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FANCHER CREEK DAM

FRESNO, CALIFORNIA

EMBANKMENT CRITERIA AND PERFORMANCE REPORT

JULY 1994

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

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1. Little Dell Lake, Salt Lake City Streams, Utah, Embankment Criteria and Performance Report, August 1994
2. Caliente Creek Stream Group Investigation California, Draft Feasibility Report, June 1987
3. Fanchier Creek Dam Fresno, California, Embankment Criteria and Performance Report, July 1994
4. Sacramento Metropolitan Area California: Final Feasibility Report and Final Environmental Impact Statement/Final Environmental Impact Report, February 1992
5. Geologic and Seismologic Investigation, Hidden and Buchanan Dams, Hensley Lake and Eastman Lake, Fresno and Chowchilla Rivers, California, December 1988
6. Sacramento River Flood Control Project, California, Mid-Valley Area, Phase III, Design Memorandum, Volumes 1 and 2, August 1995
7. Reconnaissance Report Yolo Bypass, California, March 1992
8. Provo and Vicinity, Utah, General Investigation Reconnaissance Report, April 1997
9. Sacramento-San Joaquin Delta, California, Draft Feasibility Report and Draft Environmental Impact Statement, October 1982

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FANCHER CREEK DAM
FRESNO, CALIFORNIA

PERTINENT DATA

1. General Data.

Streams	Fancher Creek Hog Creek
Drainage area at damsite	28 square miles
Flows	
200-year peak inflow	5,790 cfs
200-year peak outflow	100 cfs
SDF (PMF) peak inflow	20,600 cfs
SDF (PMF) peak outflow	7,000 cfs

2. Reservoir Data.

a. Elevation:	
Gross pool (200-year)	479.2 feet
SDF (PMF) pool	489.5 feet
b. Storage:	
Gross pool (200-year)	9,712 acre-feet
SDF (PMF) pool	20,747 acre-feet
Sediment	396 acre-feet
Maximum storage	9,316 acre-feet
c. Surface Area:	
Gross pool (200-year)	915 acres
SDF (PMF) pool	1,354 acres

3. Embankment.

Type	Homogenous rolled earth fill
Crest Elevation	492.5 feet
Crest width	25 feet
Embankment length	16,135 feet (3.1 miles)
U/S slope	Toe to crest 1V on 3H
D/S slope	Toe to crest 1V on 2H
Freeboard above maximum SDF (PMF) pool	3.0 feet

Wave runup	1.9 feet
Maximum section height	44.5 feet

4. Spillway.

Type	OGEE
Crest Elevation	479.2 feet
Crest width	55 feet
Max. discharge	7,000 cfs
SDF (PMF) pool Elevation	489.5 feet

5. Outlet Works.

Type	Ungated, box conduit, discharge to spillway chute, flow restrictor plate control
Conduit	
Dimensions	3 feet x 3 feet
Invert elevation	457.78 feet
Slope	0.0
Design release (max.)	100 cfs @ w/s Elev. 479.2
Overchute (existing)	
Type	U-channel
Invert elevation	457.78 feet
Length	94.08 feet
Width	30.0 feet

Stilling basin.

Width	40.0 feet
Length	67.0 feet
Apron elevation	437.89 feet
Design discharge	7,000 cfs

1. Purpose. The purpose of this report is to compare as-built properties of the dam with design criteria and assumptions and to document the earthwork construction activities of the project. In accordance with ER 1110-2-1901, this report provides pertinent embankment information which can be used to evaluate the performance and design of the structure along with providing guidance for the design and construction of comparable future projects.

2. Scope. The report includes a summary record of significant design data, the design assumptions, computations, and a review of specification requirements. It is a permanent record to be used as a basis of analysis for maintenance work and any future problems which may arise. The construction equipment, procedures, field control test data, record test results and embankment performance are also covered in this text.

3. Project Description.

a. General. Fancher Creek Dam is an earth-filled structure with an upstream clay slope protection zone as part of the shell and inspection trench under the upstream toe. It was constructed solely for flood control purposes. The dam intercepts and temporarily stores flows from Fancher Creek, Hog Creek and several unnamed tributaries of Redbank Creek.

The dam is located on Fancher Creek in the north-central portion of Fresno County, California approximately 7 miles east of the Fresno-Clovis metropolitan area (See Plate 1). It is situated between the San Joaquin River to the north and the Kings River to the south. The downstream channels pass through and around Fresno, draining westward ultimately into the San Joaquin River. Fancher Creek Dam will operate in conjunction with the Redbank Creek Detention Basin to provide protection for up to a 200-year flood.

The Feasibility Report and the Final Environmental Impact Statement (FEIS) for the Redbank and Fancher Creeks project were completed in February 1979 and transmitted to Congress by the Assistant Secretary of the Army for Civil Works on November 17, 1983 for authorization. The Feasibility Report and the FEIS were published as Congressional House Document No. 98-147 by the 98th Congress, 2nd Session on January 23, 1984. The dam was authorized for construction on November 16, 1986 by the Water Resources Development Act of 1986. The Local Cooperation Agreement (LCA) was signed by the Fresno Metropolitan Flood Control District on August 1, 1987. The Feature Design Memorandum for the project was approved by the South Pacific Division on November 23, 1988, and by HQUSACE on September 6, 1989. The Contract Plans and Specifications were prepared jointly by the Sacramento District and Walla Walla District Corps of Engineers.

b. Contractor and contract supervision. Construction of the Fancher Creek Dam and Appurtenances was completed by the Dutra Construction Company Inc., Rio Vista, California in 1991. The following is a list of subcontractors involved in the construction:

SUBCONTRACTOR	TYPE OF WORK
Risso Brothers	Earth Moving
Don Hickman Inc.	Structural Concrete
Jeffries & Associates	Surveying
Central Fence Co.	Fencing

Benida Steel	Reinforcing Steel
L. Reed Exc. & Paving	Demolition
Drilling 7 Blasting Co.	Blasting
Hess Electric	Electrical

The project manager for Dutra Construction was Harry Stewart. Quality control was arranged for and headed by Joseph Pigeon of Dutra Construction. Contract supervision and quality assurance was performed by the Corps of Engineers. Corps representatives included James L. LaFrenaye, Resident Engineer; Rick Hackbarth, Embankment Engineer; and O. Ira Terry and Kim Jorgensen, Project Geologists.

4. Geology.

a. Regional. The Fancher Creek Dam site lies within the Great Valley and the Sierra Nevada geomorphic provinces in an area where alluvial plains, or fans, are the dominant feature. Erosion of the Sierra Nevada Range to the east has produced a series of coalescing alluvial fans along the eastern margin of the San Joaquin Valley. The eastern Great Valley region has a gently westward slope which gives rise to moderate to steep rocky slopes of the Sierra Nevada foothills on the east. Refer to the Foundation Report for a detailed description of the geology.

The footprint of the dam occupies about 321,700 square yards (sy) of surface area including the upstream Inspection Trench. Highly weathered granodiorite, locally referred to as decomposed granite (DG), is exposed and outcrops intermittently in about 58,000 sy or 18 percent of the foundation. Residual soils mantle the upper right and left abutments and cover about 21,355 sy (7 percent) of the area. Non-liquefiable alluvial clayey soils and hardpan mantle about 84,850 sy (26 percent) of the foundation and cemented nonplastic alluvial soil (primarily sand and minor gravel) fill historic shallow valleys over about 89,770 sy (28 percent) of the foundation. Loose to firm more recent alluvial deposits fill the main stem of the Fancher Creek drainage area adjacent to the spillway and cover about 35,640 sy (11percent). Scattered patches of fat firm to stiff clay (CH) form a thin mantle over about 4,700 sy (1 percent) in the vicinity of the spillway. See Plates 4 through 24 for the locations of these various geologic units. The following describes the various geologic units.

b. Bedrock and residual soils. The predominant rock type consists of granodiorite (granitic rock referred to generally as granite) which is weathered in varying degrees or to soil when completely weathered. The granodiorite has been locally cut or intruded by gabbro and aplite dikes. The surficial exposures break down or degrade to silty sand (SM) or clayey sand (SC). The engineering properties of weathered rock (DG) are as follows:

Properties	**Range**
Decomposed Granite (DG)	SC-SM
Dry Unit Weight	121 to 148 pcf
Moisture Content	5 to 14%
Specific Gravity, G_s	2.71 to 2.90

Total Shear Strength, (U-U) S_u (Based on pocket penetrometer)	1 to 2.25 tsf+
Effective Shear Strength, (ϕ') (based on STP tests)	32 to 45°
Bearing capacity	4 tsf to 20 tsf
Coefficient of permeability (K)	0.001 ft/day to 2.0 ft/day

c. <u>Older Alluvial Sand</u>. The older alluvium has generally been cemented with iron oxide and calcium minerals. These deposits fill the historic stream courses adjacent to the abutments of the dam. These are collectively referred to as silty sand (SM). These deposits typically fill the shallow stream courses and are interbedded with clayey or cohesive layers with depth. The engineering properties of these materials are as follows:

Properties	**Range**
Classification	SM-SW
Dry Unit Weight	108 to 121 pcf
Moisture Content	14 to 21%
Specific Gravity (G_s)	2.75 to 2.79
Total Shear Strength, (U-U) S_u (Based on pocket penetrometer)	1 to 4.5 tsf
Bearing Capacity	2 to 4.5 tsf
Coefficient of Permeability	0.1 to 10 ft/day

d. <u>Clayey deposits and hardpan</u>. The clayey deposits and hardpan (CL and SC) properties are as follows.

Properties	**Range**
Classification	CL-SC
Dry Unit Weight	100 to 122 pcf
Moisture Content	12 to 25%
Specific Gravity (G_s)	2.73 to 2.79
Total Shear strength (U-U) (based on pocket penetrometer)	2 to 4.5 tsf
Coefficient of Permeability (K)	0.0001-0.001 ft/day

e. Recent alluvial sand. Recent alluvium consists of sand (SM, SW), silt (ML) and gravel (GP). The recent alluvium between Stations 106+50 to 129+00 and Stations 136+00 to 141+00 consists of loose to firm sand, silt and gravel. These deposits are generally described as loose in the Foundation Report. They vary in depth to 31 feet and constitute the most vulnerable liquefaction reach of the foundation (see Plates 16 through 19 for distribution). The engineering properties of these deposits are as follows:

Properties	Range
Classification	ML-GP
Dry Unit Weight	80-100 pcf
Moisture content	10-30%
Undrained Shear Strength (U-U) S_u, Based on pocket penetrometer	0.0-2.0 tsf
Effective Shear Strength (ϕ')(Based on N)	28°-38°
Coefficient of Permeability (K) (based on lab and field data)	0.001 to 500 ft/day
Standard Penetration (N)	3-8
Relative Density (Based on N)	30% - 60%

f. Fat clay. Scattered patches of fat clay (CH) were left in the foundation. These are typically thin (0 to 6 inches). The thin mantle is typically isolated and bounded by hardpan. An isolated zone of fat clay (3-foot maximum thickness) was encountered in the wall of the inspection trench in the vicinity of Station 133+00. This zone does not extend to the foundation surface. See Plate XXIX of the Foundation Report for the location of this zone.

g. Seismicity. A review of seismic history in the central California region presented in Fancher Creek Design Memorandum No. 6, Site Geology, indicates the fault systems which exhibit the highest probability of being a source of seismic ground motion in the Fresno area are the Owens Valley and San Andreas faults, the Foothills fault system, and faults associated with the Mammoth Lakes earthquakes.

Seismic design parameters for the project were determined using attenuation curves presented by Seed and Idriss (1983) and Bolt (1973). Those studies indicate that an earthquake of Richter magnitude 8.25 originating on the Owens Valley fault at a point 70 miles east of Fancher Creek Dam would set the upper limit of ground shaking intensity at the site. If this occurred, the result would be a peak bedrock acceleration of 0.07g (essentially at the ground surface) and a bracketed duration of 5 seconds. This low level of ground motion intensity is unlikely to create liquefaction anywhere at this site.

h. Groundwater. Groundwater level varies depending on the season, precipitation and runoff. In general, groundwater saturates the older and recent alluvium that fills the shallow valleys. The Friant-Kern Canal contributes to groundwater recharge in the vicinity of the spillway.

Valleyward groundwater levels are depressed and fluctuate in response to the amount of water pumped from numerous wells in the valley.

5. Foundation Conditions. The entire alignment of the embankment and spillway is typically underlain to shallow depths by residual soil and alluvium. Profiles along the upstream inspection trench as well as the downstream toe drain are shown in the Foundation Report. This residual soil and alluvium material at the damsite consists predominantly of sandy clay (CL) and clayey sand (SC) and silty sand (SM) from the surface to the top of the decomposed granite which varies from a depth of 2 to 10 feet. Scattered throughout the subsurface are lenses of silt, sand, and gravel in varying percentages and composition. The average gradation of samples analyzed for grain size distribution indicates the alluvium and residual soil consists of 58 percent sand, 37 percent fines and 5 percent gravel. Plasticity of the fines ranges from non to high, with low to medium plasticity constituting the majority of the values. Gradations of the underlying decomposed granite were significantly coarser than those of the alluvial and residual soils. The average gradation of the decomposed granite is 77 percent sand, 11 percent gravel and 12 percent fines. Plasticity of this decomposed granite is generally low to nonplastic. Observations indicate that the relative densities of the cohesionless material range from loose to very dense with the majority of values classified as firm. Consistencies of the cohesive material vary from soft to hard and are generally firm to stiff.

6. Embankment Features.

a. Alignment. Fancher Creek Dam is 15,820 feet in length. It is a homogeneous, rolled, earth-filled structure. It consists of an embankment dam (2,030,000 cy), concrete spillway/outlet works with an overchute crossing the Friant-Kern Canal, and a diversion channel with two bridge crossings. Turn arounds are provided at either end of the dam and every 3,000 feet. The entire alignment of the embankment, spillway/outlet works, and reservoir area is generally underlain by igneous rock and residual soil. Locally, alluvium mantles the bedrock. The granitic rock is highly weathered, or decomposed, within 2 to 10 feet of the surface. The plan view of the dam is shown on Plates 4 through 24 with the index and legend shown on Plate 3.

b. Section. The embankment section was designed in accordance with criteria contained in EM 1110-2-2300 (Earth and Rock-Fill Dams - General Design and Construction Considerations) and EM 1110-2-1902 (Stability of Earth and Rock-Fill Dams). The typical cross-section is shown on Plate 2. The crest is 25 feet wide. The upstream slope is 1V on 3H from the toe to the crest. The downstream slope is 1V on 2H from the toe to the crest. The upstream slope has a clay slope protection zone which is 4 feet thick perpendicular to the slope to prevent erosion. The surface of the slopes, upstream and downstream are turfed. An inspection trench varying in depth from 2 to 13 feet was excavated along the upstream toe to expose and cut off any near-surface continuous highly pervious strata of undesirable foundation material. The inspection trench also facilitated mapping of the near-surface strata. While excavating the inspection trench groundwater was encountered between Stations 102+00 and 128+00. Within this reach a dewatering trench was constructed upstream of the inspection trench to intercept seepage originating upstream of the dam. A well point and manifold system was installed to permit construction of the intercepter trench (Photographs 4 through 6). The dewatering interceptor trench relationship to the dam is shown on Plate 3. A horizontal drain blanket was incorporated 17 feet downstream of the centerline on the

foundation. It is composed of drain rock, 1.5 feet thick between two 9-inch-thick filters (transition material) top and bottom. A toe drain with a discharge system was also incorporated downstream and adjacent to the downstream toe. It is 4 feet wide and varies in depth from 7 to 20 feet.

c. Composite Spillway/Outlet Works. Overflow of flood discharges is accomplished with a concrete spillway with an ogee section (Photograph 29). A clay plug 20 feet wide, was constructed where the dam butts up to the structure, on both sides, in order to obtain a positive seepage cutoff at the soil/concrete interface. The clay plug parallels the concrete spillway wall, for 20 feet. It extends perpendicular to the ogee section, for 20 feet, for the entire height of the dam. This plug will significantly reduce the piping potential at the interface between soil and concrete.

(1) Outlet works: An ungated outlet works was constructed for operational simplicity. The outlet release was determined by routing of the design flood through the dam and to the downstream Redbank and Fancher Creek stream system with the objective of reducing reservoir storage without overtaxing the downstream control facilities. The outlet works is designed for a discharge of 100 cfs at gross pool (elevation 479.2 feet). The outlet passes through the ogee spillway at an invert elevation of 457.78 feet. The outlet works is a 3-foot square concrete conduit. To limit the maximum discharge to 100 cfs at gross pool, a steel flow restrictor has been placed just downstream of the entrance roof curve with an opening of 1.25 feet and a lip shape similar to the conventional slide gate.

At discharges below 25 cfs, flow will be considered open channel. A 6-inch-diameter air vent has been provided to ensure a positive air supply to prevent cavitation at the flow restrictor and the conduit is steel lined for 5 feet 6 inches on the sides and bottom. To prevent plugging, the conduit is protected with a 6.5 feet wide by 9 feet high trashrack with a bar spacing of 2.16 feet by 0.75 feet.

(2) Spillway: The spillway approach channel walls consist of two sets of retaining walls. The walls vary in height from 3.2 feet at the upstream end to 35.5 feet at the downstream end and are 131 feet long. The flood event designs are set to an elevation of 479.2 feet for a 200-year event and 464.5 feet for a 25-year event. The water surface rises to elevation 489.5 feet at the Probable Maximum Flood (PMF).

The ogee section consists of a U-wall through the dam crest to retain embankment soils and a mass concrete ogee crest between the walls for water control purposes. The ogee will be inundated 0.1-foot during the PMF. At gross pool, the ogee provides a headwater surface elevation of 479.2 feet and a tailwater surface elevation of 459.8 feet.

The spillway chute is a U-channel which converges from a width of 55 feet, at the ogee crest, to 30 feet over a length of 224 feet. The design insures that flow passes smoothly over the overchute. Tailwater elevation at the chute is 459.78 feet for the 25-year event, 460.78 feet for the 200-year event, and 464.78 feet for the spillway design flood (PMF).

The overchute safely discharges flow to Fancher Creek, during both the 200-year and the spillway design flood events. The downstream end of the spillway chute is connected to the overchute. However the two structures are separated by an expansion joint to ensure that the new chute will not damage or spall the old structure. The Spillway Design Flood (PMF) has been determined to be 7000 cfs which can be adequately passed with the raised chute walls. The dam is designed to safely pass the PMF with 3 feet of freeboard.

(3) Stilling Basin: A parabolic drop connects the overchute with the stilling basin. It abuts the downstream end of the Fancher Creek chute which has an upstream elevation of 465.0 feet and a downstream elevation of 441.4 feet. The structure smoothly passes water into the stilling basin prior to its final discharge into Redbank Creek. The stilling basin is 67 feet long by 40 feet wide with an apron elevation of 437.9 feet. Two rows of baffle blocks dissipate energy. The walls of the basin have 3 feet of freeboard during a PMF. Elevations for a spillway design flood are 440.3 feet at the upstream end and 459.0 feet at the downstream end.

d. Seepage Control. Steady-state seepage conditions through the embankment will not develop due to the limited duration of impoundment and the low pressure head. Maximum impoundment durations will be limited to 6 months and maximum pressure heads generated during standard flood conditions will be on the order of 20 feet. Further, the upstream clay slope protection zone restricts seepage into the embankment as well as protects the slope from erosion due to wave action. In addition, valleys were filled and the upstream ground surface sloped away from the upstream toe of the dam. This blanket will further reduce seepage. Additional seepage control is provided by the natural impervious surface deposits which mantle the foundation to a distance of 500 feet upstream from the dam. This natural blanket lengthens the potential foundation seepage paths, thus reducing the severity of any potential exit gradients.

Some foundation seepage is anticipated. To minimize seepage and reduce the potential for foundation piping, seepage control features such as the inspection trench, which will intercept near surface pervious water-bearing layers, the horizontal drain blanket and the downstream toe drain have been incorporated into the design.

Any minor seepage through the embankment and upper foundation will be collected in the horizontal blanket and toe drain. The horizontal drain blanket was constructed of 18 inches of gravel (drain rock) and protected with 9 inches of sand (filter material) encapsulating the top, bottom and the upstream end. The horizontal drain blanket was placed on the dam foundation, 17 feet downstream of the dam centerline and daylights at the downstream toe. It starts at Station 53+70 and ends at Station 158+10. The toe drain was constructed adjacent to and downstream of the downstream toe. It is 4 feet wide and extends below the ground surface to elevation 457.0 feet at it's beginning (Station 53+70), elevation 457.5 feet at it's end (Station 158+10) and elevation 442.3 feet at the outfall point (Station 76+00). The location of the toe drain is shown on Plates 9 through 24. The toe drain is lined with filter fabric which encapsulates the drain rock backfill. When the toe drain intercepts seepage, water is transported to the foundation low point in a 24-inch-diameter perforated, high density polyethylene, corrugated pipe (Photographs 7 and 8). The water is then discharged under the Friant-Kern Canal via a cross drain syphon.

7. Embankment Materials. A summary of the design estimate quantities and the as-built embankment quantities are shown in Table 1.

a. Random Fill (Embankment and Inspection Trench). Random fill material was borrowed from decomposed granite, residual soil and alluvial deposits. The Supplemental Instructions to the Engineering Considerations and Instructions for Field Personnel (revised September 1990) required compaction to 99 percent (with none less than 95 percent) of maximum density as per ASTM D 698 within plus or minus 2 percent of optimum moisture content. This dense material provides a high strength and a relatively impervious embankment. Early stages of compaction was achieved as per

specifications using a 50-ton rubber-tired roller. On 29 October 1990 (after a value engineering test fill was completed and accepted), a single-drum roller was substituted for the originally specified 50-ton rubber-tired roller. Material used for the inspection trench included clayey sand (SC) and silty sand (SM). These soils exhibit low permeability and possess acceptable consolidation properties and act as a partial cutoff for near-surface seepage control. Initial fill compaction was completed as per specifications using towed tamping-foot rollers as shown in Photograph 18. On 29 October 1990, self-propelled, single-drum, tamping-foot, vibratory, V-E rollers (Photograph 19) were then used. These rollers made three coverages at 3.5 mph on 6-inch-thick compacted lifts until the trench was completed. Construction control values are summarized in Table 2. Graphs showing a summary of the construction control data are shown on Plates 25 and 26.

b. Clay Slope Protection. Clay slope protection material was selectively borrowed to ensure a fine grained material with low to moderately high plasticity. This allows for good strength and low permeability and will reduce the amount of erosion on the upstream slope of the dam. Compaction was completed as per specifications up to 10 January 1991, then a Caterpillar 825C roller was substituted and used through 30 April 91 (Photograph 20). The Caterpillar 825C made six coverages at 3.5 mph on 6-inch-thick compacted lifts to complete the clay slope protection. Construction control values are summarized in Table 2. Graphs showing a summary of the construction control data are shown on Plate 27.

c. Random Fill, Clay Slope Protection and Clay Plug at the Spillway/Outlet Works. The embankment was completed 30 April 1991 except adjacent to both the north and south sides of the Spillway/Outlet Works. At this time the Spillway/Outlet Works was not completed, therefore, the embankment could not be placed up to the structure until a later date. As can be seen on Plates 19 & 20, the Spillway/Outlet Works centerline is located at Station 130+00. To allow time for the completion of the Spillway/Outlet Works the dam embankment was left incomplete between Stations 129+00 and 131+00. On 26 August 1991 a separate fill operation was started for this location. Dutra Construction rather than Risso Bros. performed this operation with a completely different crew than used for the rest of the embankment. The hand compaction between and around the counterforts as well as within 10 feet along the rest of the structure was performed using a backhoe (Case 780), a walk-behind tamping-foot roller (Ingersoll-Rand FX-130), and two hand operated power tampers. The fill placed outside of the hand compacted area was placed with two scrapers (CAT 615C and an International). Grading was performed with a D-6 Caterpillar Bulldozer and compaction with an Ingersoll-Rand SD 100F (static load of 13 tons and dynamic load of 25 tons). The Ingersoll-Rand compactor has 4-inch-high tamping feet with an area of 21 square inches mounted on a 7-foot-wide drum.

The above fill operation also included the random fill and clay slope protection as per the contract drawings. Moisture conditioning of these materials was performed at the borrow sites (see Plate 3 for borrow site locations) using water trucks and 30-inch-diameter disks pulled with a Caterpillar 824B to blend the soils. To insure a positive cutoff of seepage between the soil/concrete interface a clay plug was added during construction. This clay plug is located on the north and south sides of the structure downstream of the counterforts. It extends 20 feet downstream from the last downstream counterfort and 20 feet perpendicular to the spillway wall (see Photographs 25 and 26). The plug begins at the foundation of the dam and extends to the crest of the dam. The summary of the construction control test results for the three zones are shown on Plates 28 through 30.

d. Drainage Fill, Horizontal Drain Blanket. The contract specification gradation for drain material was not available near the project. However, the available and similar material in the area was checked for filtration and permeability requirements against the available filter material and random fill. This material was found suitable and was therefore approved for use. The following table is a comparison of the contract specifications and used drainage fill gradations.

Sieve Size	Percent by weight, passing	
	Specified Gradation	As-built & Field Tested
3/4"	100	100
1/2"	90 - 100	60 - 100
3/8"	40 - 70	13 - 92
#4	0 - 15	4 - 21
#8	0 - 5	3 - 9
#16		2 - 6
#30		2 - 4
#50		1 - 3

e. Filter Material. Material meeting the contract specification gradation for filter material was also not available near the project. However, material in the local incomplete CZ detention basin owned by the Fresno Metropolitan Flood Control District area was checked for filtration and permeability requirements against the available drain fill and random fill. This material was found suitable and was therefore approved for use. The following table is a comparison of the contract specifications and used filter material gradations.

Sieve Size	Percent by weight, passing	
	Specified Gradation	As-built & Field Tested
3/8"	100	100
#4	95 - 100	99 - 100
#8	80 - 100	92 - 96
#16	50 - 85	64 - 76
#30	25 - 60	26 - 42
#50	10 - 30	9 - 20
#100	2 - 10	3 - 7

f. Drainage Fill, Toe Drain. As with the horizontal drain blanket material, drainage material for the toe drain was not available near the project. However, the available material in the area was found suitable and therefore approved for use. The following table is a comparison of the contract specifications and used drainage fill gradations.

Sieve Size	Percent by weight, passing	
	Specified Gradation	As-built & Field Tested
3/4"	100	100
1/2"	90 - 100	74 - 100
3/8"	40 - 70	23 - 94
#4	0 - 15	5 - 31
#8	0 - 5	3 - 15
#16		3 - 10
#30		2 - 7
#50		2 - 5

g. Riprap Bedding. The following table shows the riprap bedding gradation used at the spillway. The sieve analysis was supplied by RMC Lonestar, the supplier.

Sieve Size	Percent by weight, passing	
	Specified Gradation	As-built & Supplier Tested
3"	100	100
3/4"	55-75	64
#4	15-35	30
#200	0-10	5

h. Riprap (18" thick). The following table shows the 18-inch-thick riprap gradation used at the spillway.

Weight (pounds)	Percent Smaller (by weight)
	Specified & As-built & Supplier Tested
90	100
33	45-95
15	15-45
5	0-15

i. Riprap (42-inch-thick and Grouted). The following table shows the 42-inch thick layer of and the Grouted Riprap, and the 24 inches thick used at the spillway.

Weight (pounds)	Percent by Weight Passing	
	Specified Gradation	As-built & Field Tested
1100	100	100
420	45-95	55
190	15-45	29
70	0-15	9

8. Material Sources.

a. Embankments. Embankment material (random fill and clay slope protection) were borrowed from upstream borrow sites (Plate 3). The clay came from the surface of the borrow areas and the random material came from subsurface.

b. Filter zones. Filter material was borrowed from recent alluvial deposits along Big Dry Creek where the CZ basin was in the process of being excavated. This material was granular and provided adequate drainage properties.

c. Drainage Fill. The supplier, Lone Star, has two sources, the San Joaquin River and the Kings River. Both sources were utilized.

d. Riprap. The riprap for this project came from the Pine Flat spoil area downstream from the Dam. The material was processed utilizing a grizzly screen at the Pine Flat site. The material was then checked for gradation weight (size) at the Fancher Dam site using a previously installed and licensed scale.

e. Water. The water for dust control and compaction came from the Friant-Kern Canal and groundwater pumped from an exiting well and from the dewatering trench described in paragraph 6.b.

9. Construction Sequence.

a. First Year. The dam was constructed during two construction seasons. The first season included mobilization and site preparation to include clearing and stripping of the area. Excavation and embankment placement was started the first season (July 1990 through February 1991) with the contract requirement to complete the embankment to elevation of 474.5 feet to ensure a 25-year flood could be contained. The construction of the spillway and the outlet works was also initiated at the end of the first construction season.

b. Second Year. During the second construction season (May 1991 through October 1991), the placement of the embankment was continued and completed. Additionally, the spillway and the outlet works construction were also continued until the completion of the project in October 1991.

10. Quality Assurance and Testing.

a. General. This effort involved the combined activities of the Corps of Engineers inspectors and laboratory personnel. Extensive field laboratory testing was performed on the embankment materials. Record samples were also obtained by the Sacramento District for shear strength and permeability testing by the South Pacific Division (SPD) Laboratory.

b. Contractor Quality Control (CQC). Contract provisions required the Contractor to confirm embankment quality. To complete the moisture tests and lift thickness tests and ensure compliance with the specifications, a Quality Control Engineer was appointed by the Contractor to perform the following functions:

(1) Visit the fill on a daily basis to ensure proper moisture control. Monitor the fill operations and advise the fill foreman regarding lift thickness, processing and compacting procedures.

(2) Prepare a daily quality control report for the Project Engineer's review. This report included fill activities, and described quality control surveillance activities and instructions.

c. Government Inspection and Laboratory Testing.

(1) General: A Corps construction inspector was assigned to constantly monitor the fill operations performed by the Contractor. A field soils laboratory provided continuous testing support to assure design and construction compliance. A comprehensive testing program was developed with special emphasis placed on critical or difficult areas of fill placements. All tests were performed in accordance with ASTM standards, except when otherwise indicated.

(2) Field Control Testing: The sand cone method (ASTM D1556) was performed

to determine the field density of random and impervious fill (Photograph 28). The upper one or two lifts of fill were bladed from the area to be tested and a smooth, even surface was prepared. Then a hole was dug 4 to 6 inches deep and approximately 6 inches in diameter. Excavated material was weighed and taken back to the laboratory to determine moisture content. Extra material was taken adjacent to the sand cone test sites for laboratory maximum density determinations on every fifth field test. A field density test was conducted on every 3,000 to 4,000 cubic yds of material placed.

(3) Laboratory Testing:

(a) Moisture Content: Soil samples for moisture content were obtained concurrently with sand cone density testing. The moisture content was then determined in accordance with ASTM D 2216.

(b) Gradation Tests: Soil samples for gradation determinations were obtained in the field concurrently with the sand cone density testing. The gradation tests were then performed in accordance with ASTM D 422.

(c) Moisture-Density Tests: Moisture-density relationships as per ASTM D 698 were determined in the field laboratory. A family of compaction curves representing typical soil types were developed prior to the start of fill placement and updated as required during placement and were used to monitor the fill procedure. Initially, a standard five-point compaction test was performed for each field density test. This was desirable due to variations in material properties. Later, field density tests were evaluated using a one-point laboratory test with every fifth test being a five-point test.

(d) Specific Gravity and Atterberg Limits: Specific gravity and Atterberg limits tests were performed for nearly every five-point compaction test taken during the fill operations. They were performed in accordance with ASTM C 127 & ASTM D 4318.

11. Record Sampling.

a. General. A record sampling and testing program was conducted to establish the strength and permeability properties of the constructed embankment. This testing was conducted in coordination with the field. The frequency, location, and scope of testing were developed during the design phase and the early construction period. The testing consisted of sieve analysis, Atterberg Limits, water content, visual classification, triaxial compression tests, and permeability. The record sample test results are presented on Plates 31 and 32. All record samples collected from the embankment during construction were tested by the South Pacific Division (SPD) Laboratory located in Sausalito, California. The test results are contained in two reports dated 27 March 1991 and 14 June 1991. This data is included as Appendix A.

b. Record Sampling. Undisturbed record samples of the embankment fill were obtained from the clay slope protection and random fill zone on two occasions (Photographs 21-23). In December 1990, three 10-inch-diameter tube (one 12-inch-long and two 9-inch-long) samples were excavated from the clay slope protection (Station 59+30, elevation 467.78 feet) and three 10-inch-

diameter, 18-inch-long samples were excavated from the random fill zone (Station 30+00, elevation 481.91 feet) of the embankment. In February 1991, three 10-inch-diameter by 15-inch-long tube samples were excavated from the random fill zone at Station 110+05, elevation 487.14 feet and three similar samples were excavated in the random fill zone at Station 148+12, elevation 480.82 feet. In each case, the sampling was performed by geotechnical personnel from the Sacramento District. The Contractor provided a backhoe to perform the rough excavation. Samples were carefully carved from the remaining soil block and enclosed in cylindrical PVC pipe and wax-sealed. The samples were then delivered to the SPD Division Laboratory for testing. Record sample testing included consolidated-undrained triaxial shear tests with pore pressure measurements, permeability tests and classification tests.

c. Test Results.

(1) Random Fill: Laboratory record sampling test results of the random material are shown on Plate 31 and a summary of the design and as-built physical properties are shown in Table 3. Three series of R-bar shear strength tests were performed. Each series consisted of three Mohr's circles. The samples tested were typical of the materials placed in the embankment random fill. Typical embankment random fill material was a clayey sand (SC). The triaxial shear testing resulted in a selected consolidated-undrained ("CU" or "R") triaxial shear strength of $\phi = 15°$ and c = 1.6 ksf, compared to $\phi = 15°$ and c = 3.2 ksf used during design. Consolidated-drained ("CD" or "S") test results determined from pore pressure measurements resulted in a selected drained strength of $\phi' = 34°$ compared to $\phi' = 38°$ used during design. Permeability testing of three samples resulted in a range of vertical permeability, $k_v = 2.8 \times 10^{-8}$ cm/sec to 4.8×10^{-7} cm/sec and a horizontal permeability, $k_h = 4.3 \times 10^{-8}$ cm/sec to 3.2×10^{-6} cm/sec. The average effective permeability from these test results is $k = 6.8 \times 10^{-7}$ cm/sec or 0.002 ft/day. This is significantly less than the 1 ft/day assumed during design. Based on these results, the assumption in design that a steady state seepage condition through the embankment will not develop, is validated.

(2) Clay Slope Protection: Laboratory record sampling test results of the clay slope protection are shown on Plate 32, and a summary of the design and as-built physical properties are shown in Table 3. Three R-bar shear strength tests were performed. The samples tested were typical, although on the coarser side of average for sandy clay (CL) to clayey sand (SC) slope protection materials. The triaxial shear testing resulted in a selected consolidated-undrained ("CU" or "R") triaxial shear strength of $\phi = 10°$ and c = 0.3 ksf, compared to $\phi = 15°$ and c = 0.4 ksf used during design. One of the three tests resulted in a relatively high strength of approximately 1.6 ksf. However, this particular sample had a density of 122 pcf, which is the upper 10 percentile of all densities as determined from field density tests. Consolidated-drained ("CD" or "S") test results determined from pore pressure measurements resulted in a drained strength of $\phi' = 34°$. This is the same value used during design. Permeability testing of two samples resulted in a range of vertical permeability, "k_v" of 9.3×10^{-7} cm/sec to 3.2×10^{-6} cm/sec. The average vertical permeability from these test results is $k_{avg.} = 2.1 \times 10^{-6}$ cm/sec or 0.006 ft/day. Similar to the random fill, this permeability value is significantly less than the 0.1 ft/day permeability assumed in design.

(3) Drain Rock and Filter Material: As-built physical properties of these materials were not determined. However, they are assumed to be the same as the design physical properties.

See Table 4.

12. Construction Procedures.

a. Clay Slope Protection. The material for the clay slope protection was moisture conditioned at the borrow sites. It was then excavated and transported with Caterpillar 660 scrapers. It was spread on the fill and then final moisture conditioning was accomplished by spraying with a water wagon, similar to the random fill. It was compacted as discussed in paragraph 7b.

b. Random Fill. The foundation was stripped and prepared for fill (Photographs 1 and 2). This also required the blasting and removal of a large granitic knob (no alluvium under it) (a hard, very large boulder remaining after the surrounding granitic rock had weathered) at Station 48+60. An attempt was made to moisture condition the borrow sites (Photograph 9). However, due to the type of excavation used (the Holland Excavator can cut up to 13 feet deep at one time) this was not effective (Photograph 10). Random fill for the embankment was excavated and loaded by a Holland excavator into the Holland belly-dumps (Photographs 11 through 14). The material was then hauled to the damsite for processing and compaction (Photograph 15). Water was added to the random material and the disks worked it in to obtain a well blended material at near optimum moisture content (Photograph 17). Random material was spread in lifts which, after compaction, had an average thickness of 6 inches. Lift thickness was controlled by visual inspection and with the use of hand levels. After spreading, water was added using a water wagon. Each lift of fill was compacted with three passes of a vibratory roller (Photograph 19). After compaction, the surface of the fill was scarified to a depth of 2 to 3 inches with a 32-inch-diameter disk-plow to provide proper bonding for the subsequent lift. Random Fill also came from the inspection trench and diversion channel excavations. They were excavated using Caterpillar 660 scrapers and push dozers. When soft material was encountered Caterpillar 637 scrapers were utilized, as shown in Photograph 3. The inspection trench excavation between Stations 102+00 and 128+00 required excavating below the groundwater table (Photograph 4). A dewatering system was installed as discussed in the Foundation Report (Photographs 5 and 6). After the inspection trench was inspected and geologically mapped, backfill began with Caterpillar 660 scrapers (Photograph 16).

c. Toe Drain. The toe drain was excavated between Stations 53+70 and 158+10 with a Caterpillar 235 excavator, geologically mapped as shown in the Foundation Report and constructed as shown in Photographs 7 and 8. Where hard rock was encountered a process called "hydraulic fracturing" (not to be confused with hydraulic fracturing of soil) was used to obtain the required grade. This process involved drilling 4-inch-diameter holes approximately 3 to 4 feet into the rock, inserting the mechanical apparatus into the hole, and then injecting the hydraulics into the apparatus with high pressure, at which time it spread thus splitting the rock (see the Foundation Report for details).

d. Dam Closure at the Spillway. At the time of completion of the Spillway/Outlet Works the embankment was complete except adjacent to the Spillway/Outlet Works structure,as discussed in paragraph 7c. The clay plug material was excavated, hauled, spread and rolled similar to the random fill. Much of the clay plug at the spillway was compacted with hand tamping equipment to ensure thorough compaction near the concrete retaining walls of the completed Spillway/Outlet

Works structure (Photographs 24 through 27). Graphs showing a summary of the construction control data for this earth work are shown on Plates 28 through 30.

e. Horizontal Drain. The filter material was placed with belly-dump trucks, and a scraper followed, spreading the material. It was then compacted with three passes of a smooth drum roller with the vibrator off. Next, the drain rock was placed at the upstream end of the horizontal drain and then spread with a D6-dozer. It was then compacted with three passes of a smooth-drum roller with the vibrator off. The top layer of filter material was placed using the same procedure as the drain rock placement.

13. Instrumentation. In order to monitor embankment settlement and horizontal movement, survey monuments have been installed on the embankment crest. The monuments are spaced at approximately 500-foot intervals.

To monitor the phreatic surface through the embankment and foundation groundwater levels, piezometers were installed. Piezometers were installed at the downstream edge of the crest and at the downstream toe of the dam. Seven of the piezometer locations at the crest have double piezometers. One extends into the foundation and one terminates at the foundation/embankment contact. See Table 5 for piezometer locations and depth. The instruments are spaced at approximately 1000-foot intervals to cover the entire length of the dam. All 37 open-tube type 2piezometers are equipped with a 5-foot slotted interval constructed of 3/4" I.D. PVC pipe and fitted with a bottom cap. Blank 3/4" I.D. PVC pipe extends above the ground/fill surface and is fitted with a top cap and protected with an 18-inch-diameter lockable CMP housing.

Piezometers designated "A" and "B" are piezometer pairs installed in the same bore hole except for piezometers P-19A and B which were installed in separate holes. The "A" designation indicates tips which are placed below the embankment in the foundation. "B" piezometers have tips located at the embankment/foundation contact. Even numbered piezometers are located along the downstream toe of the dam.

14. Embankment Slope Stability. Record sample test results of the random fill material are generally slightly lower than the shear strength values used in design. Therefore, the as-built minimum factors of safety are accordingly lower than those determined during design. The Table below summarizes the factors of safety calculated in the stability analyses and also lists the factors of safety reported in the Fancher Creek Dam Feature Design Memorandum. Although the as-built factors of safety are less than determined during design, they do meet minimum criteria. The stability analyses were performed using the modified Swedish method in accordance with EM1110-2-1902. The slope stability programs used were UTEXAS3 developed by Stephen G. Wright of the University of Texas in 1992 and the Slip Circle program developed in 1968 by the St. Paul District, U.S. Army Corps of Engineers. Strength properties of the foundation and drainage materials were the same as those used during design. The random fill and the clay slope protection strength properties were selected to reflect those strengths selected from the record samples. Soil unit weights were also modified slightly to reflect more closely the unit weight of the actual material placed in the embankment as determined from quality assurance testing. The minimum factor of safety failure arcs for the steady seepage, partial pool, and the sudden drawdown conditions are shown on Plates 33 through 35.

STABILITY ANALYSES			
CONDITION ANALYZED	REQUIRED FACTOR OF SAFETY per EM1110-2-1902	FEATURE DM FACTOR OF SAFETY	AS-BUILT FACTOR OF SAFETY
STEADY SEEPAGE	1.5 1.0 w/seismic loading	1.7 1.4	1.51 1.20
PARTIAL POOL	1.5 1.0 w/seismic loading	2.2 1.5	1.97 1.36
SUDDEN DRAWDOWN (From Spillway Crest)	1.2 Seismic loading N/A	1.5	1.20

15. Construction Notes.

a. Modifications. Modifications were made at the project to improve the embankment or to optimize utilization of materials and equipment. Change order modifications are listed in Table 6.

b. Equipment. Various construction equipment used throughout the course of the project are listed in Table 7.

16. Operations and Maintenance.

a. General. The Local Sponsor, Fresno Metropolitan Flood Control District (FMFCD), will operate and maintain Fancher Creek Dam in accordance with the Local Cooperation Agreement (LCA) and the Water Control and Operations & Maintenance manuals.

b. Operations. The outlet works is ungated and thus, gate operations are not required. Outflow from the dam is controlled by a flow restrictor and is designed to release floodwaters in conjunction with other controls in a coordinated manner. Normal flood control operations include daily monitoring of flows and reservoir stages to facilitate the appropriate changes of gates throughout the Fresno-Clovis flood control system. Additionally, a complete record of operations will be tabulated and made available for inspection upon request.

c. Maintenance. All embankments and cut-slopes should be kept mowed; additionally, efforts are required to prevent burrowing animal or other external (vehicular) damage to embankments. All project channels should be maintained to their design grade, invert elevation and capacity and kept clear of sediment and debris in order to maintain the design capacities of the exit channels and culverts. Riprap and compacted clay used for erosion protection must be maintained and kept free of vegetation. All features of the Fancher Creek Dam, along with the diverting canals and erosion protection features, will be inspected annually for functional adequacy in accordance

with Sect. 7, 58 Stat. 890, 33 USC 709 (As per Title 33 of Code of Federal Regulations).

17. Proposed Monitoring. While monitoring the piezometers, notes should be made about the Friant-Kern Canal (i.e. does it have water in it or is it dry), and the siphon at the toe drain outlet (is it flowing with water and if so how deep). And, any future surveys of the Embankment Crest Alignment Monuments should be comparied with the survey results shown in Table 8.

18. Summary. The embankment was constructed as designed in accordance with the contract plans and specifications. Field and record test results confirm density and strength characteristics of the fill. High quality embankment materials and sound construction practices produced a dense, high strength embankment. Compaction of the embankment is considered superior. Limited observation of instrumentation data indicate the dam is performing in accordance with the design concept and will provide the necessary level of flood protection in the area.

TABLES

TABLE 1

EMBANKMENT QUANTITIES

EMBANKMENT ITEM	QUANTITY	
	DESIGN ESTIMATE	AS-BUILT
Inspection Trench (CY)	100,000	98,181
Random Fill (CY)	1,730,000	1,614,724
Clay Slope Protection (CY)	215,000	205,525
Horizontal Drain Transition Fill (TONS)	74,000	80,840
Horizontal Drain Drainage Fill (TONS)	62,500	56,631
Toe Drain Drainage Fill (TONS)	26,600	20,614

TABLE 2

CONSTRUCTION CONTROL SUMMARY OF EMBANKMENT MATERIALS

PART I	RANDOM FILL, INSPECTION TRENCH		
	Maximum	**Minimum**	**Average**
Field Dry Density, γ_d	129	110	119
Moisture, ω	16	8	11
% Compaction	103	93	98
Moisture Variation	1.6	-2.1	-0.4
LL -- 27-34 PI -- 14-19 SC (Clayey Sand) to SM (Silty Sand)			

PART II	RANDOM FILL, EMBANKMENT		
	Maximum	**Minimum**	**Average**
Field Dry Density, γ_d	130	106	120
Moisture, ω	18	8.2	12
% Compaction	104	95	99
Moisture Variation	1.8	-2.2	-0.4
LL -- 13-35 PI -- 2-29 and NP SC (Clayey Sand) to CL (Sandy Clay) and SM (Silty Sand) to ML (Sandy Silt)			

PART III	CLAY SLOPE PROTECTION		
	Maximum	**Minimum**	**Average**
Field Dry Density, γ_d	123	98	112
Moisture, ω	22	10	16
% Compaction	105	95	99
Moisture Variation	2.2	-2.1	.01
LL -- 16-67 PI -- 3-38 CL (Sandy Clay) to SC (Clayey Sand)			

TABLE 3

DESIGN VS AS-BUILT PHYSICAL PROPERTIES

PARAMETERS	RANDOM FILL		CLAY SLOPE PROTECTION	
	DESIGN	AS-BUILT	DESIGN	AS-BUILT
Dry Unit Weight, γ_d	118.5 PCF	119.6 PCF	118.6 PCF	111.3 PCF
Moist Unit Weight, γ_m	131.0 PCF	134.0 PCF	131.6 PCF	130.0 PCF
Saturated Unit Weight, γ_s	137.8 PCF	138.0 PCF	137.6 PCF	133.0 PCF
Submerged Unit Weight, γ_b	75.4 PCF	75.6 PCF	75.2 PCF	70.6 PCF
Unconsolidated-Undrained "Q" Strength	C=800 PSF $\phi = 31°$	Not Tested	C=1000 PSF $\phi = 10°$	Not Tested
Consolidated-Undrained "R" Strength	C=3200 PSF $\phi = 15°$	C=1600 PSF $\phi = 15°$	C=400 PSF $\phi = 15°$	C=300 PSF $\phi = 10°$
Consolidated-Drained "S" Strength	C=0 $\phi = 38°$	C=0 $\phi = 34°$	C=0 $\phi = 34°$	C=0 $\phi = 34°$
Coefficient of Permeability "K"	1 FPD	0.002 FPD	0.1 FPD	0.006 FPD
Specific Gravity	2.75	2.68	2.73	2.62

TABLE 4

DESIGN VS AS-BUILT PHYSICAL PROPERTIES OF FILTER & DRAINAGE MATERIALS

PARAMETERS	DESIGN	AS-BUILT (ASSUMED)
Dry Unit Weight	115.0 PCF	115.0 PCF
Moist Unit Weight	125.0 PCF	125.0 PCF
Saturated Unit Weight	130.0 PCF	130.0 PCF
Submerged Unit Weight	67.6 PCF	67.6 PCF
Unconsolidated-Undrained "Q"	C=0 PSF $\phi = 36°$	C=0 PSF $\phi = 36°$
Consolidated-Undrained "R"	C=0 PSF $\phi = 36°$	C=O PSF $\phi = 36°$
Consolidated-Drained "S"	C=0 PSF $\phi = 36°$	C=0 PSF $\phi = 36°$
Coefficient of Permeability "K"	1000 FPD	1000 FPD
Specific Gravity	2.65	2.65

TABLE 5

OPEN TUBE PIEZOMETERS

PIEZO NAME	STATION	ELEV. TOP PVC (FT.)	1 MAR 93 READING (FT.)	DEPTH TO BOTTOM (FT.)	FEATURE
P-1	20+00	494.55	30.10	37.30	FND
P-2	20+00	484.27	DRY	17.20	D/S TOE
P-3	30+00	494.48	31.85	36.30	FND
P-4	30+00	478.00	15.50	18.95	D/S TOE
P-5	40+00	494.25	32.76	40.90	FND
P-6	40+00	468.55	7.60	21.52	D/S TOE
P-7	50+00	493.92	33.07	44.40	FND
P-8	50+00	468.55	9.00	15.03	D/S TOE
P-9A	60+00	494.21	38.60	52.48	FND
P-9B	60+00	494.44	DRY	33.40	FND CONTACT
P-10	60+00	465.51	10.03	21.90	D/S TOE
P-11A	70+00	494.26	42.64	49.85	FND
P-11B	70+00	494.67	34.00	34.10	FND CONTACT
P-12	70+00	463.12	12.20	23.05	D/S TOE
P-13A	80+00	494.39	48.30	59.64	FND
P-13B	80+00	494.65	DRY	31.70	FND CONTACT
P-14	80+00	455.13	10.22	21.35	D/S TOE
P-15A	90+00	494.52	50.52	63.49	FND
P-15B	90+00	494.64	42.02	42.04	FND CONTACT
P-16	90+00	457.25	14.26	22.90	D/S TOE
P-17	100+00	494.13	46.99	54.99	FND
P-18	100+00	462.16	15.79	21.10	D/S TOE
P-19A	110+00	493.90	41.64	65.49	FND
P-19B	110+09	494.32	35.45	35.72	FND CONTACT
P-20	110+00	461.57	11.02	20.72	D/S TOE

TABLE 5 (cont.)					
OPEN TUBE PIEZOMETERS					
PIEZO NAME	STATION	ELEV. TOP PVC (FT.)	1 MAR 93 READING (FT.)	DEPTH TO BOTTOM (FT.)	FEATURE
P-21A	120+00	494.21	43.35	45.90	FND
P-21B	120+00	494.32	DRY	31.95	FND CONTACT
P-22	120+00	460.02	11.62	15.55	D/S TOE
P-23	128+00	494.00	43.99	50.85	FND
P-24	128+00	458.43	10.95	16.84	D/S TOE
P-25	134+00	494.16	42.72	63.72	FND
P-26	134+00	460.12	9.68	23.35	D/S TOE
P-27A	140+00	494.08	45.30	56.54	FND
P-27B	140+00	494.45	DRY	36.47	FND CONTACT
P-28	140+00	460.11	12.34	21.57	D/S TOE
P-29	150+00	494.18	43.78	56.34	FND
P-30	150+00	457.14	8.65	16.12	D/S TOE

TABLE 6

CONSTRUCTION CHANGE ORDER MODIFICATIONS

DATE	DESCRIPTION	BASIS
22 Aug 1990	Change Top of Toe Drain From Gravel to Clay Cap	Prevent Surface Runoff from Entering Drain
6 Nov 1990	Provide Concrete Slab with Aluminum Awning for Lab Facility	Facilitates Processing of Lab Tests & Protects Equipment
7 Nov 1990	Provide 2 Cleanouts & 8 Manholes Plus Ladders	Necessary for Dam Safety
13 Nov 1990	Deepen Footing of Stilling Basin & Place Concrete	Footing Not Sufficient to Contain Material
14 Nov 1990	Remove Rock on the Side Slopes of the Foundation	Remove Rock Found in the Foundation to Remove Seepage Path
17 Dec 1990	Remove Rock & Dewater Toe Drain Trench	Hard Rock Formation Found in the Trench
22 Jan 1991	Provide Cover that is Subject to Frequent Flow	Necessary to Meet Requirements
22 Jan 1991	Provide Drainage System in the Stilling Basin	Groundwater Problem & Hydrostatic Pressure
30 Jan 1991	Construct a Control Joint from the Foundation to the OGEE Surface	Reduce & Control Cracking in the Ogee Due to Temp Differentials
1 Feb 1991	Modify Slope Protection & Clay Blanket to Classify as Clay	Ensure Material used for Protection is Specified as Clay
7 Feb 1991	Provide Additional Steel Reinforcement in Spillway Chute Walls	Changes in Soil Pressure Calculations Required Increased Strength
19 Mar 1991	Excavate an Interceptor Trench at Bottom of Inspection Trench	Standing Groundwater Encountered during the Excavation

TABLE 6 (cont.)

CONSTRUCTION CHANGE ORDER MODIFICATIONS

DATE	DESCRIPTION	BASIS
19 Apr 1991	Provide Clay Material for Backfill Against Outlet Structure	Prevent Seepage at Soil/Concrete Contact
20 Jun 1991	Backfill 10 Well Points Formerly used for Dewatering System	Safety Hazard & Water Contamination due to Open Holes
18 Dec 1991	Install Diversion Channel & Change Access Roads	Prevent Possible Downstream Flooding
15 Feb 1992	Install Stilling Basin Fence with Gates for Security	Due to Expansion & Improvement of Stilling Basin
27 Feb 1992	Provide Pavement Overlays	Tie in Turnaround with Asphalt Pavement Ends

TABLE 7

EQUIPMENT USED TO PROCESS, TRANSPORT, AND PLACE FILL

Description	No.	Contractor or Subcontractor	Remarks
Caterpillar Loader 966D	1	Dutra	For placing drain rock in the Toe Drain & Dewatering Trench
Caterpillar 245 Excavator	1	Dutra	Stilling Basin Excavation
Caterpillar 235 Excavator	2	Dutra	Toe Drain Excavation & Dewatering Trench Excavation
Caterpillar D6H Dozer	1	Dutra	Swamp Cat for working in the mud
Pettibone MK36 Crane	1	Don Hickman	Concrete Structure, moving forms
Caterpillar 637D Scrapers	2	Risso Bros.	For working in soft excavations
Caterpillar D9 Dozer	3	Risso Bros.	Pushed 660 scrapers during cut, spread fill & rip borrow sites
Caterpillar Challenger CH65	1	Risso Bros.	Pulled fill processing disk
Caterpillar 641 Waterpull	1	Risso Bros.	Moisture conditioning fill and keeping the haul roads dust free
Caterpillar Grader 14G	2	Risso Bros.	Kept haul roads and ramps smooth & spread fill out
Caterpillar 660 Scrapers	8	Risso Bros.	Moved borrow to fill (inspection trench and clay slope protection)
Caterpillar Grader 140G	1	Risso Bros.	Kept haul roads and ramps smooth & spread fill out
Caterpillar 633 Scraper	1	Risso Bros.	Clean-up & Finish work in the Inspection Trench
Case 4894 Tractor	1	Risso Bros.	Pulled fill processing disk
Holland 600 Loader	1	Holland Const.	Borrow Site Excavation
Holland 610 Loader	1	Holland Const.	Borrow Site Excavation

TABLE 7 (cont.)

EQUIPMENT USED TO PROCESS, TRANSPORT, AND PLACE FILL

Description	No.	Contractor or Subcontractor	Remarks
Holland 700 Loader	1	Holland Const.	Borrow Site Excavation
Holland 180 Haul Truck	6	Holland Const.	Haul Excavated Material to the Fill
Holland HL180 Haul Truck	4	Holland Const.	Haul Excavated Material to the Fill
Holland Boom Truck	1	Holland Const.	Mechanic Yard, for lift heavy parts
Caterpillar D8 Dozer	2	Risso Bros.	Pulled rubber tire roller then pulled fill processing disk
Kenworth Truck w/Crane	1	Risso Bros.	Maintenance Yard & set pumps
Ingersol Rand SD100	5	Risso Bros.	Vibratory Roller, for compacting Random Fill
Dynapac CA25PD	3	Risso Bros.	Vibratory Roller, for compacting Random Fill
Caterpillar 825C	2	Risso Bros.	Static Roller, for compacting Clay Slope Protection
Caterpillar 631 Waterpull	1	Risso Bros.	Moisture conditioning fill and keeping the haul roads dust free
RT Grove RT58D Crane	1	Dutra	Helped with pile driving operation
9125ATC 140 Ton Crane	1	Dutra	Held pile driver at the Bullard Bridge
Caterpillar 824B Rubber Tire Roller	1	Risso Bros.	Compacted fill prior to the V-E roller acceptance
Mobil B57 Drill Rig	1	B & B Drilling	Installing Observation Wells
Case 680K Backhoe	1	Dutra	Shaped relocated Nees Rd. embankment toe for rock fill

TABLE 8

EMBANKMENT CREST ALIGNMENT MONUMENTS				
MONUMENT	STATION	NORTHING	EASTING	ELEVATION (FT.)
SJ-11-14	10+00	2,194,022.515	6,404,522.453	492.571
SJ-11-15	15+00	2,193,522.342	6,404,515.685	492.512
SJ-11-16	20+00	2,193,022.412	6,404,509.041	492.529
SJ-11-17	25+00	2,192,522.154	6,404,502.604	492.558
SJ-11-18	30+00	2,192,022.384	6,404,496.240	492.660
SJ-11-19	35+00	2,191,522.431	6,404,489.504	492.489
SJ-11-20	40+00	2,191,022.458	6,404,482.942	492.420
SJ-11-21	45+00	2,190,522.482	6,404,476.502	492.732
SJ-11-22	50+00	2,190,022.424	6,404,470.121	492.689
SJ-11-23	55+00	2,189,522.475	6,404,463.605	492.538
SJ-11-24	60+00	2,189,022.403	6,404,457.106	492.555
SJ-11-25	65+00	2,188,522.637	6,404,450.728	492.499
SJ-11-26	70+00	2,188,022.806	6,404,444.015	492.725
SJ-11-27	75+00	2,187,522.741	6,404,437.559	492.492
SJ-11-28	80+00	2,187,022.955	6,404,431,384	492.519
SJ-11-29	85+00	2,186,522.983	6,404,424.711	492.620
SJ-11-30	90+00	2,186,024.158	6,404,431.161	492.483
SJ-11-31	95+00	2,185,624.545	6,404,747.978	492.634
SJ-11-32	100+00	2,185,280.209	6,405,092.318	492.489
SJ-11-33	105+00	2,184,917.884	6,405,436.973	492.476
SJ-11-34	110+00	2,184,555.582	6,405,781.663	492.709
SJ-11-35	115+00	2,184,158.391	6,406,080.685	492.745
SJ-11-36	120+00	2,183,729.330	6,406,337.515	492.492
SJ-11-37	125+00	2,183,294.216	6,406,580.747	492.811
SJ-11-38	129+50	2,182,844.686	6,406,586.970	492.699
SJ-11-39	130+50	2,182,744.788	6,406,586.363	492.719

TABLE 8 (cont.)				
EMBANKMENT CREST ALIGNMENT MONUMENTS				
MONUMENT	**STATION**	**NORTHING**	**EASTING**	**ELEVATION (FT.)**
SJ-11-40	135+00	2,182,302.666	6,406,586.363	492.473
SJ-11-41	140+00	2,181,816.194	6,406,772.606	492.450
SJ-11-42	145+00	2,181,330.808	6,406,891.297	492.591
SJ-11-43	150+00	2,181,125.730	6,407,311.641	492.374
SJ-11-44	155+00	2,181,074.926	6,407,809.094	492.348
SJ-11-45	160+00	2,181,024.080	6,408,306.550	492.515
PRIMARY CONTROL MONUMENTS				
MONUMENT	**NORTHING**	**EASTING**	**ELEVATION (FT.)**	**NOTES**
J 803	2,177,852.344	6,398,899.158	417.22	
ACADEMY RESET	2,201,768.920	6,398,682.737	493.07	
USBR B.M. K 803	2,177,719.605	6,404,706.013	428.55	NO ELEV. (DERIVED FROM GPS)
ROUND	2,181,596.336	6,412,321.335	869.01	DERIVED FROM GPS
USBR 17.26	2,193,374.741	6,398,591.045	461.10	
CONSTRUCTION CONTROL MONUMENT				
FC-3	2,194,357.003	6,403,916.024	486.42	

General Notes:

1. Initial Crest Alignment Monument locations determined by PSOMAS and Associates, November 1991. NAD83, CALIFORNIA, ZONE 4, STATE PLANE VALUES in U.S. Survey Feet. Elevations determined from differential levels. See drawing SJ-11-20-35 sheet C-43 45 Project Instrumentation for details on installation.

2. Global Positioning Service Satellites (GPS)

PHOTOGRAPHS

Photo 17 Disc used to process the soil. 15 Oct. 1990

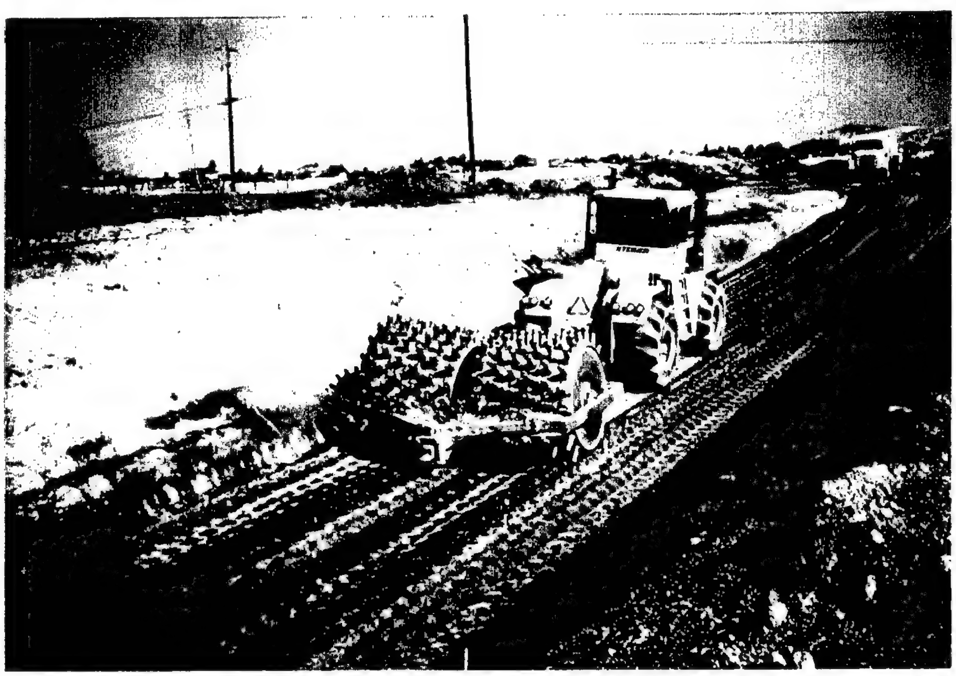


Photo 18 Towed roller used for compaction in the inspection trench. 8 Oct. 1990

Photo 19 Dynapac and Ingersol Rand rollers compacting the embankment. 15 Oct. 1990

Photo 20 Cat 825 roller

Photo 21 Early stages of carving undisturbed sample for record sample program. 3 Dec 1990

Photo 22 Final sizing and shaping of undisturbed sample prior to encapsulating in PVC tube. 3 Dec. 1990

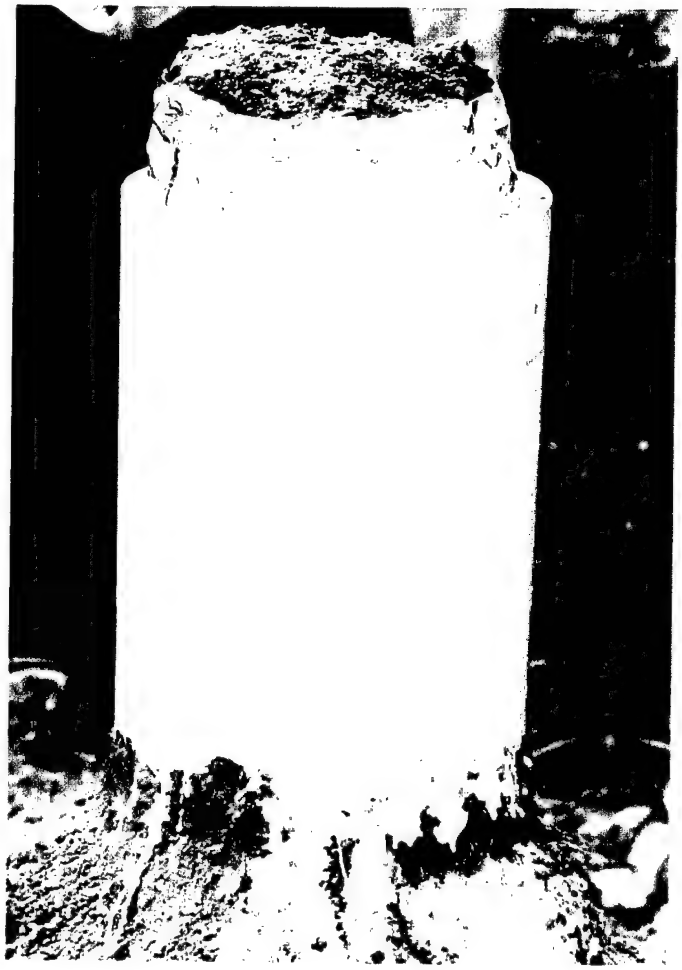


Photo 23 Record sample encapsulated in PVC tube and waxed. 3 Dec. 1990

Photo 24 The clay material being compacted, and in the background the clay is being moisture conditioned.

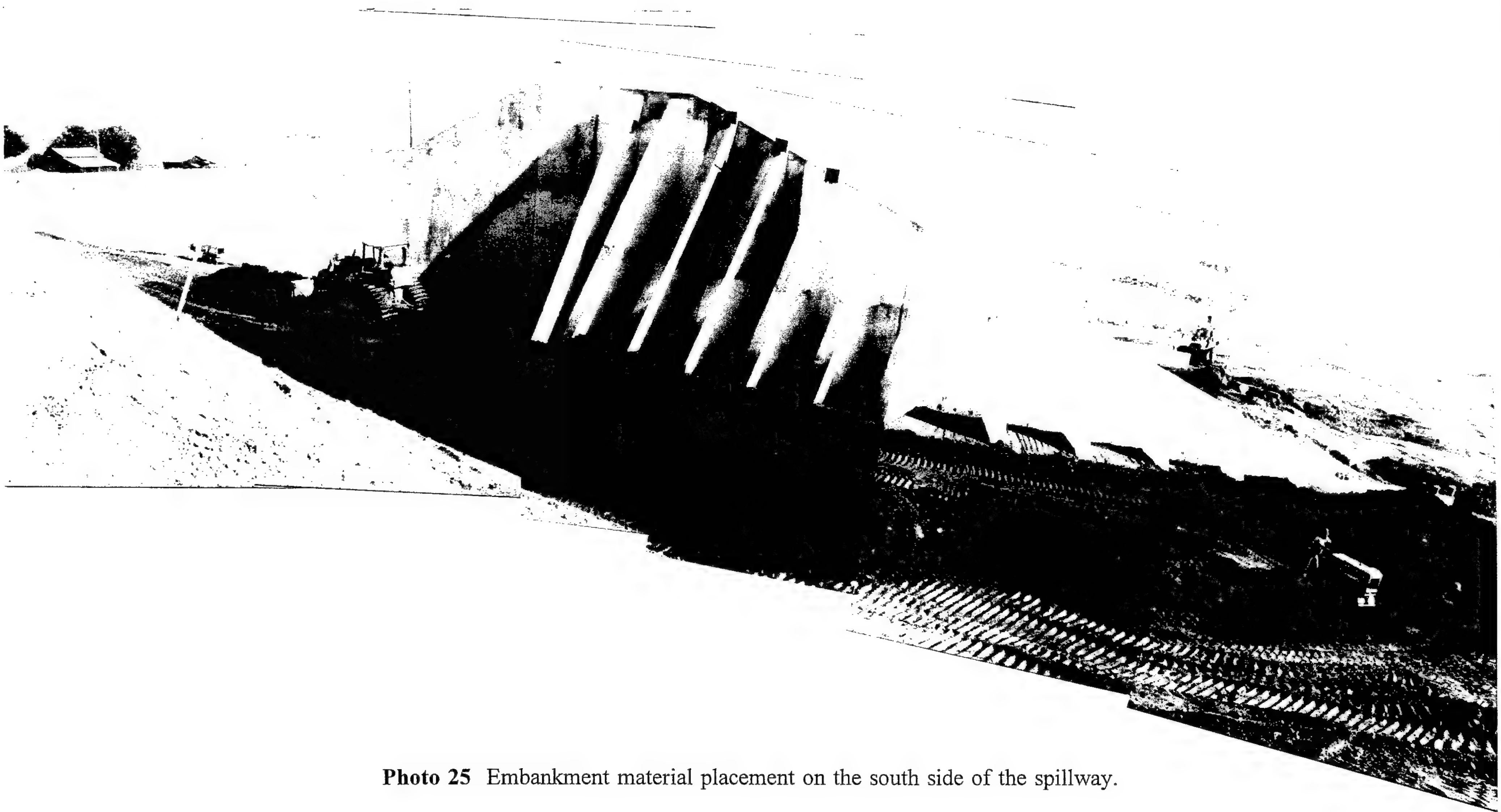


Photo 25 Embankment material placement on the south side of the spillway.

Photo 26 Compacting material at the spillway, soil/concrete interface.

Photo 27 The random material being compacted between the counterforts.

Photo 28 Testing the fill.

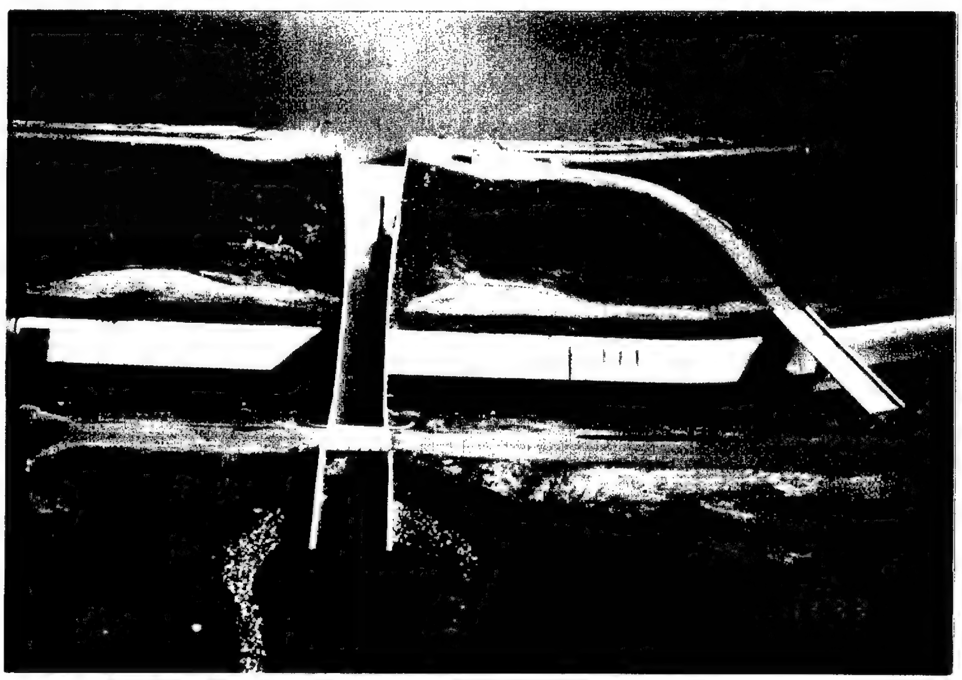


Photo 29 Aerial view of the outlet works/spillway 14 January 1993.

Photo 1 Dam Station 160+00 looking west at the prepared foundation. 18 Oct. 1990

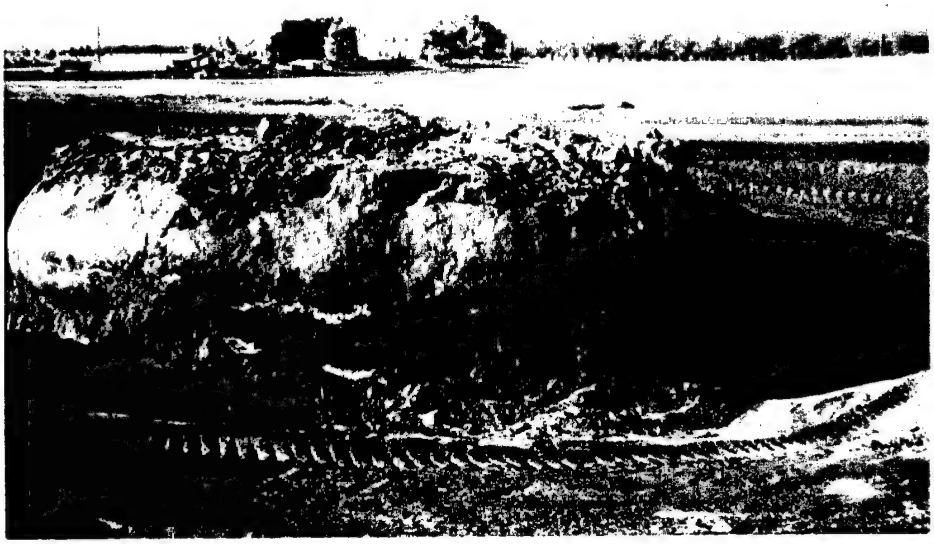


Photo 2 Dam Station 48+60, rock in foundation was blasted and removed. 28 Sept. 1990

Photo 3 Inspection Trench excavation with two Cat 637 scrapers. 30 Oct. 1990

Photo 4 Inspection Trench, Stations 102+00 and 128+00 prior to dewatering. 23 Oct. 1990

Photo 5 Dewatering system, showing risers leading into the pipe manifold. 20 Oct. 1990

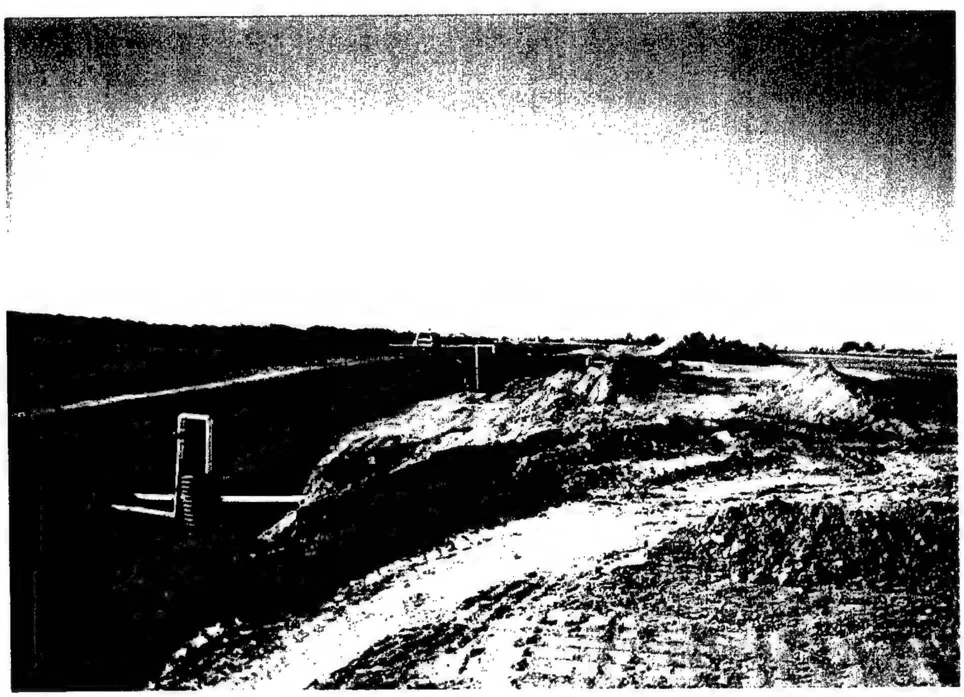


Photo 6 Dewatering system between Dam Stations 102+00 and 128+00. 20 Oct. 1990

Photo 7 Cat 235 Excavator, placing pipe bedding material in the Toe Drain. 29 Aug. 1990

Photo 8 Toe Drain- fabric, bedding material, pipe and drain rock being placed. 29 Aug. 1990

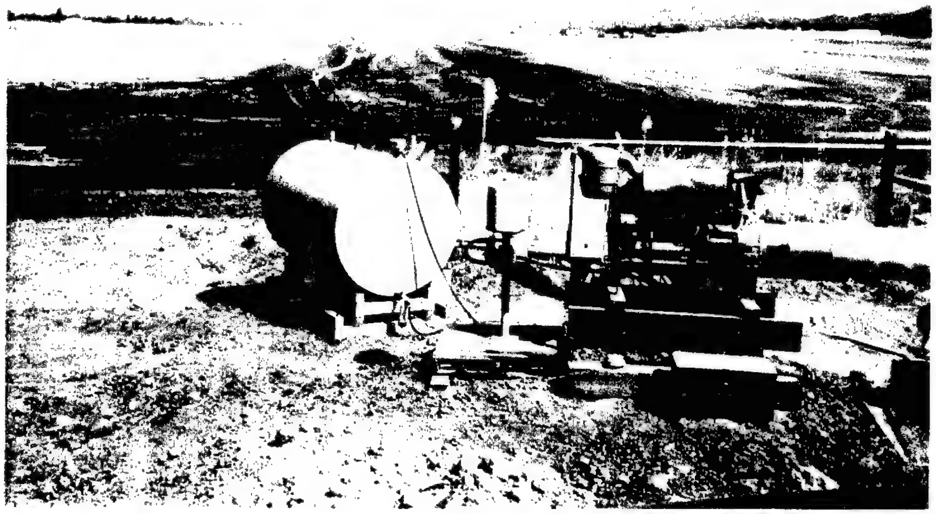


Photo 9 An attempt at moisture conditioning in the borrow pit. 17 Aug. 1990

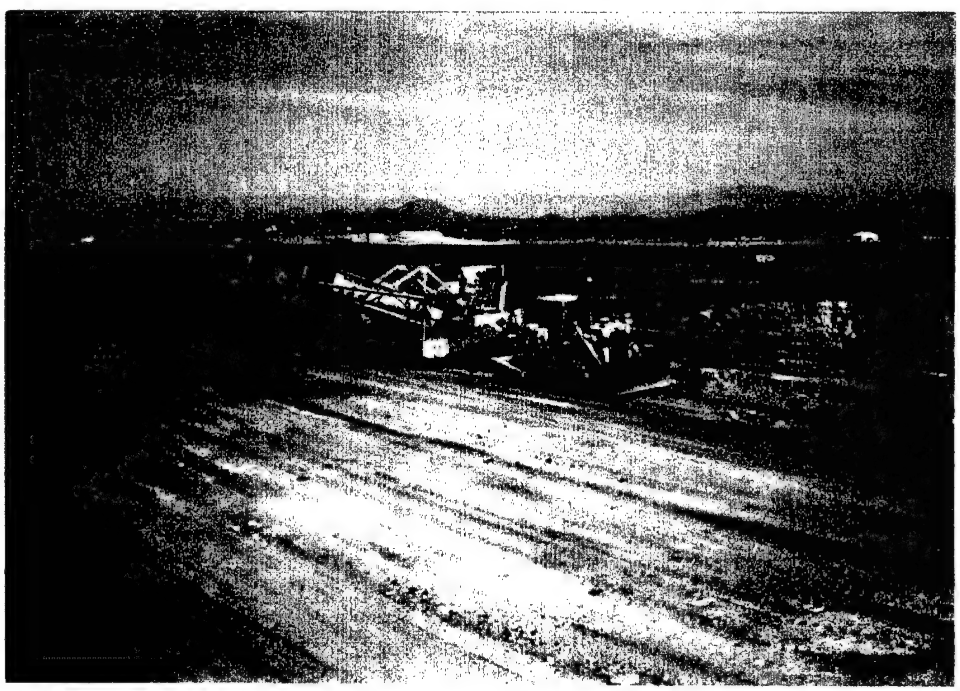


Photo 10 Holland excavator, side cut. 7 Jan. 1991

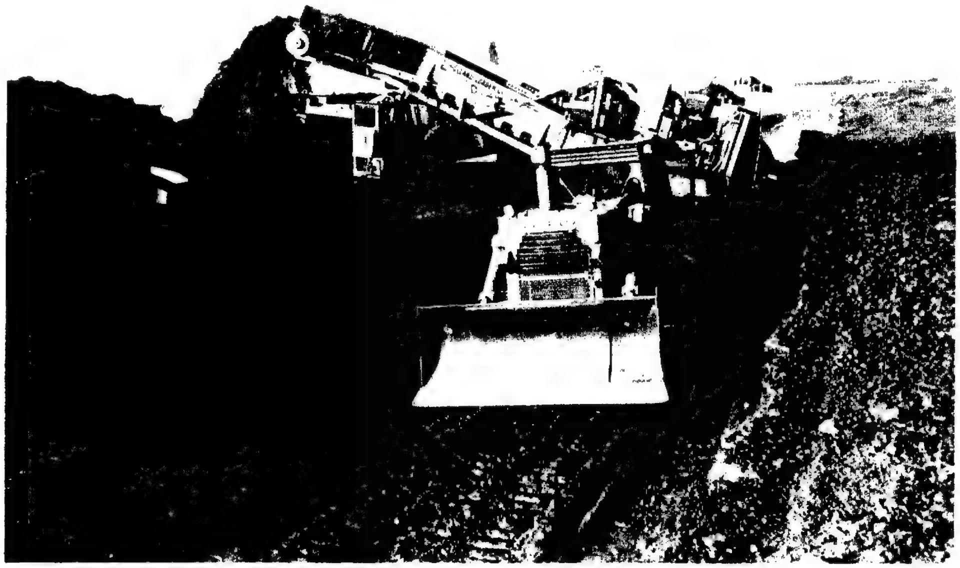


Photo 11 Holland side cut excavator loading a Holland Wagon. 7 Jan. 1991

Photo 12 Holland side cut excavator close-up. 7 Jan. 1991

Photo 13 Holland side cut excavator from the rear. 7 Jan. 1991

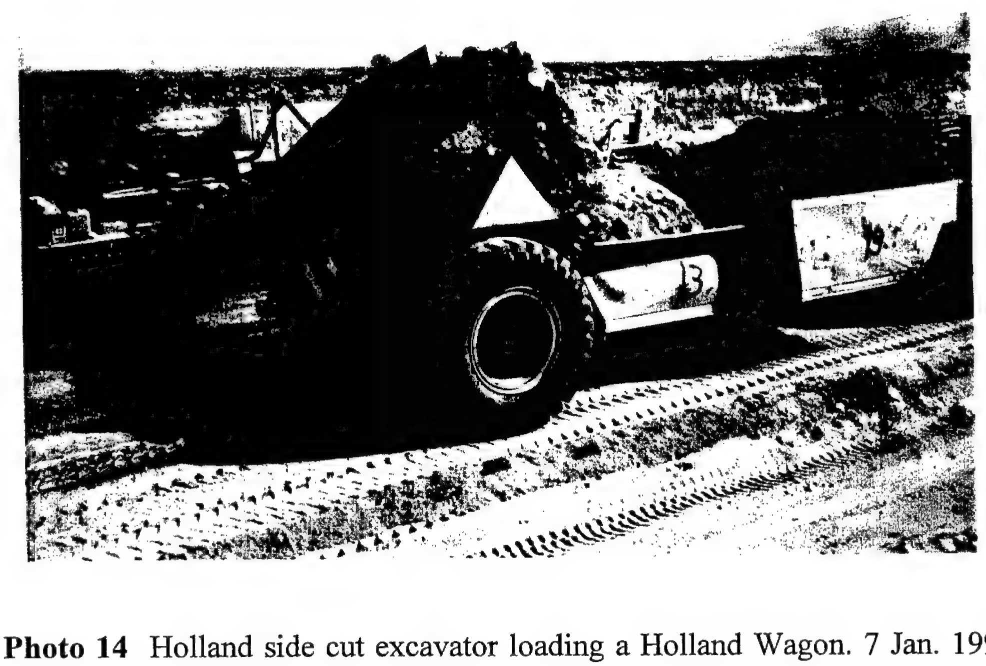


Photo 14 Holland side cut excavator loading a Holland Wagon. 7 Jan. 1991

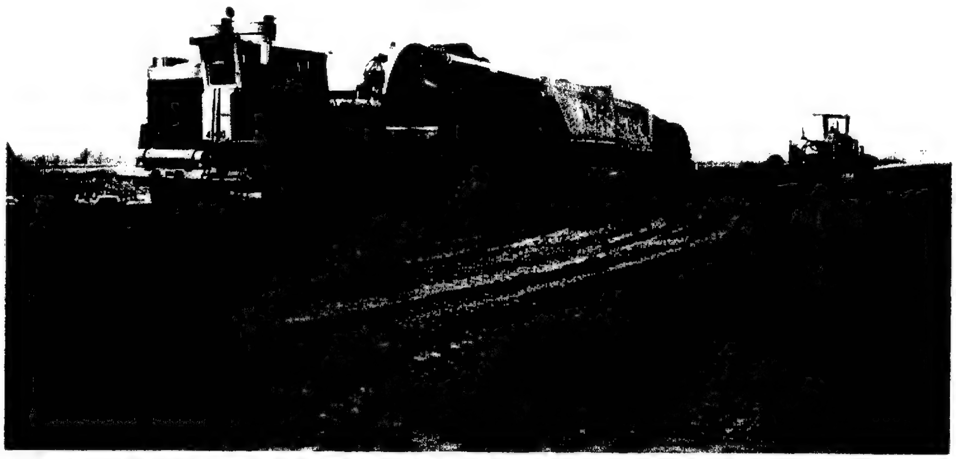
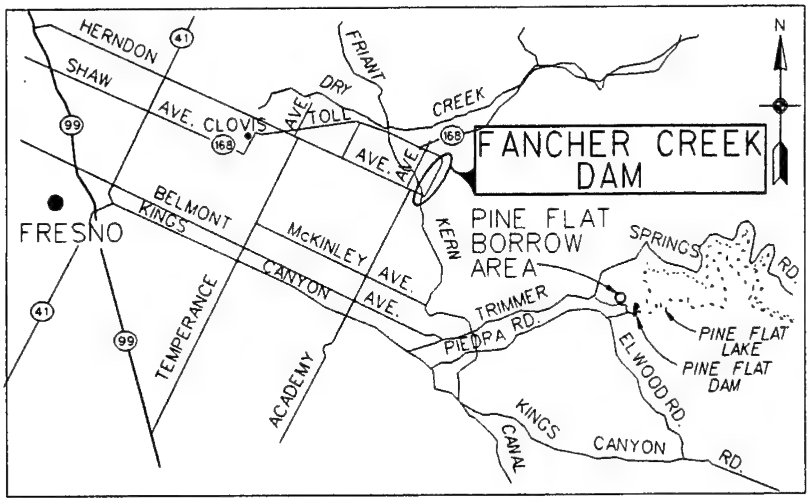


Photo 15 Holland Wagon dumping soil on fill, grader spreading the material. 15 Oct. 1990

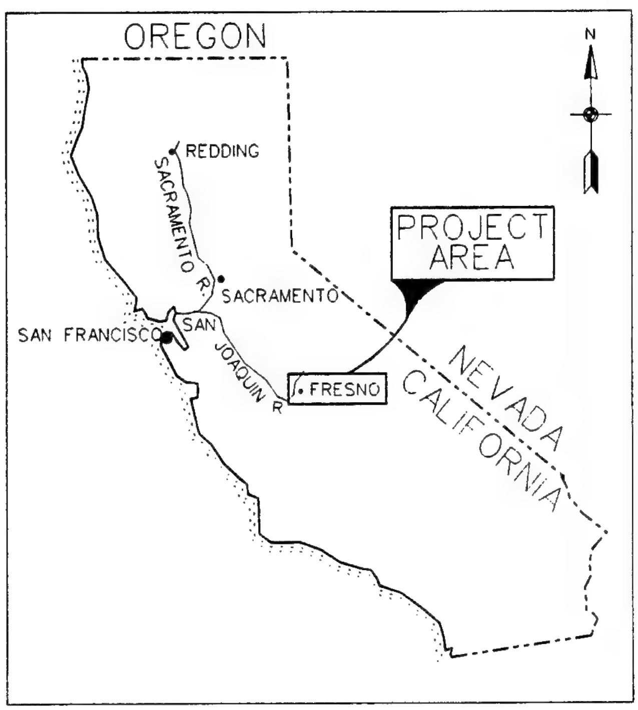
Photo 16 Cat 660 scraper dumping fill in the inspection trench. 15 Oct. 1990

PLATES

REDBANK AND FANCHER CREEKS, CALIFORNIA
FANCHER CREEK DAM



LOCATION MAP



VICINITY MAP

FANCHER CREEK DAM
REDBANK AND FANCHER CREEKS FRESNO, CALIFORNIA

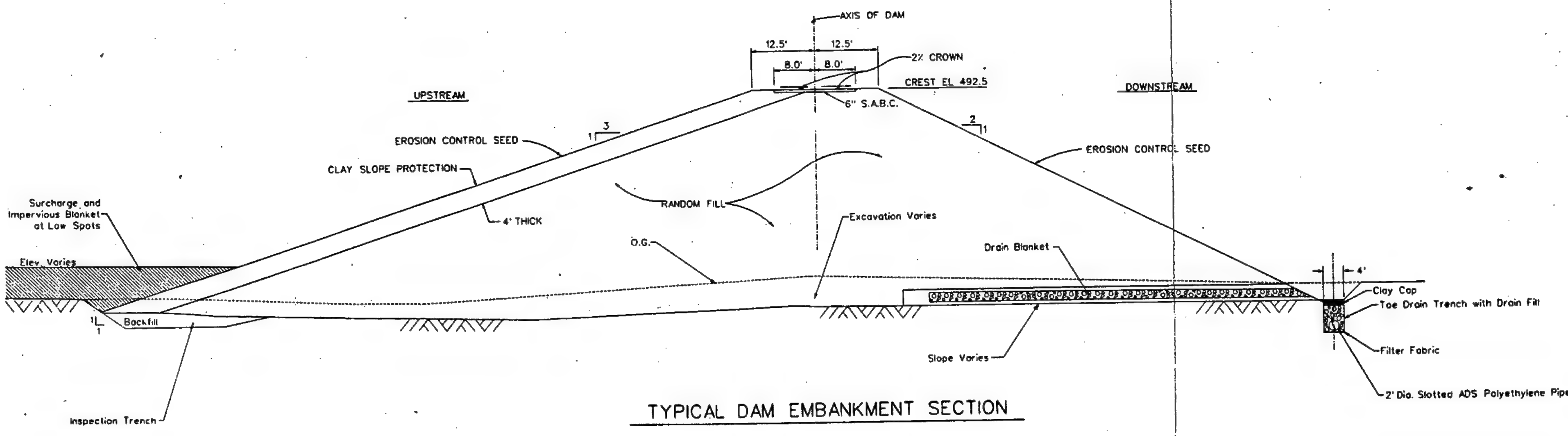
PROJECT VICINITY MAP

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SUBMITTED R. HACKBARTH EMBANKMENT ENGINEER	SUBMITTED RESIDENT ENGINEER
DRAWN BY R. BRADLEY	FILE No: ----
CHECKED BY: D. RICKETTS	SHEET 1 OF ____ SHEETS

MICROSTATION FILE: SOIL DESIGN SECTION \ POD \ FD-MAP 4-13-94

PLATE 1



TYPICAL DAM EMBANKMENT SECTION

SPECIFICATION REQUIREMENTS FOR EMBANKMENT MATERIALS

MATERIAL	Inspection Trench	Random Fill	Clay Slope Protection	Transition Fill	Drainage Fill
Gradation Requirements	-6" 100% SM, SC, ML, CL	-6" 100% GM, GC, SM, SC, ML, CL	-6" 100% CL, 30<LL<50	-3/8" 100% -#100 2-10%	-3/4" 100% -#8 0-5%
Moisture Content - Variation +/- Optimum	-2% to +2%	-2% to +2%	-2% to +2%	-------	-------
Loose Lift Thickness	8"	8"	8"	12"	12"
Compactive Effort	4 passes rubber tire roller 6 passes tamping foot roller 3 passes V-E roller*	4 passes rubber tire roller 6 passes tamping foot roller 3 passes V-E roller*	4 passes rubber tire roller 6 passes tamping foot roller 3 passes V-E roller*	4 passes vibratory roller	4 passes vibratory roller
Minimum On-Grade Processing	2 passes with 36" Diameter Plow Disc	2 passes with 36" Diameter Plow Disc	2 passes with 36" Diameter Plow Disc	-------	-------
Density Requirements	95% min. Std. Comp. 99% avg.	95% min. Std. Comp. 99% avg.	95% min. Std. Comp. 99% avg.	-------	-------
Quantities	98,181 CY	1,614,724 CY	205,525 CY	80,840 Tons	CY

* After completion of a test program in which required density was shown to be obtainable, the self-propelled single drum tamping foot vibratory roller was accepted on the project. These rollers made 3 coverages at 3.5 mph on 6-inch compacted lifts. These rollers were brought onto the project 29 Oct '90.

GRAPHIC SCALE

10 0 10 20 30 FEET

SCALE: 1" = 20 FEET

FANCHER CREEK DAM
REDBANK AND FANCHER CREEKS FRESNO, CALIFORNIA

TYPICAL EMBANKMENT SECTION AND PLACEMENT REQUIREMENTS

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SUBMITTED: R. HACKBARTH, EMBANKMENT ENGINEER

SUBMITTED: RESIDENT ENGINEER

DRAWN BY: R. BRADLEY

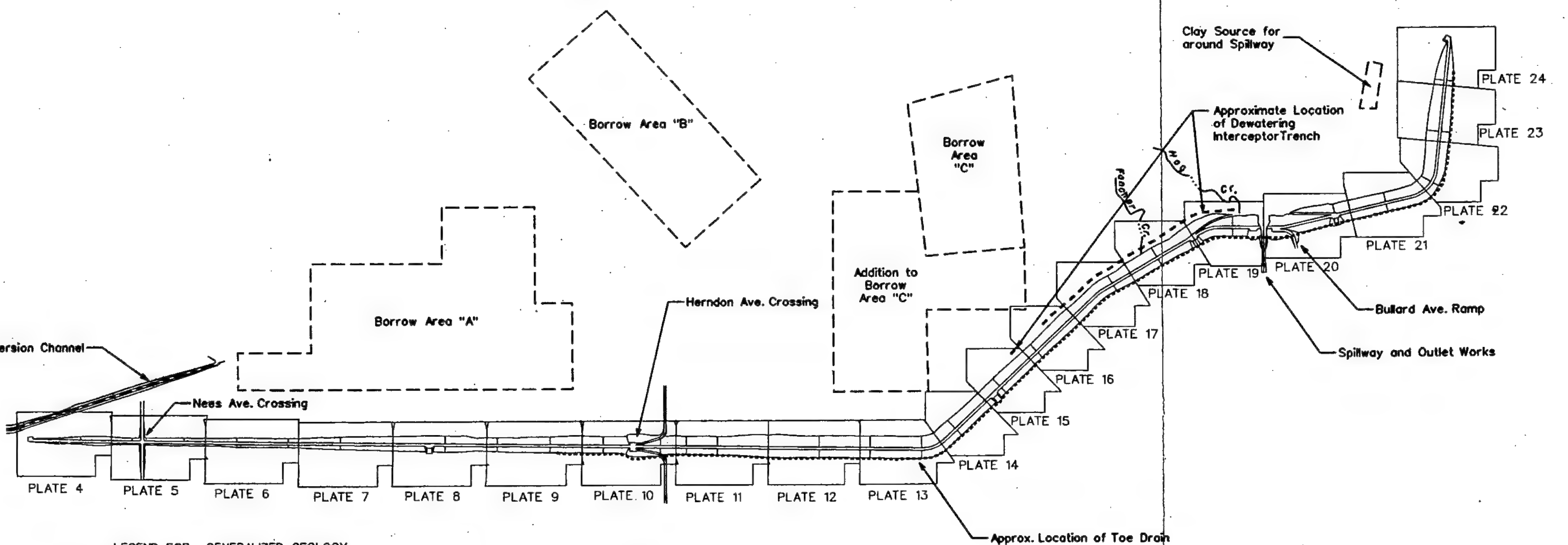
CHECKED BY: D. RICKETTS

FILE No. ----

SHEET ___ OF ___ SHEETS

PLATE 2

MICROSTATION PC FILE: SOIL DESIGN SEC. \ RMB \ FDTYPXS.DGN 5-11-94



LEGEND FOR GENERALIZED GEOLOGY

Granodiorite with local Gabbro, highly weathered (DG) generally referenced to a decomposed granite. Typically rippable, fragments crumble under hand pressure. Unconfined compressive strength greater than 4.5 tsf.

SM Predominantly silty sand (SM); residual soil 0-4 feet thick (avg. 2 feet).

Approx. Sta. 12+30 to 26+00: U.C.= 2 to 4.5 tsf (avg. 4.0 tsf).

SP-SM-SW. Silty sand (SM) and some sand (SP & SW), alluvial, typically cemented, firm to dense.

Approx. Sta. 30+25 to 49+50: U.C.= 0.75 to 4.5 tsf (avg. 2.75 tsf); 1 to 4 feet thick (avg. 2 feet).

Approx. Sta. 56+00 to 63+15: very firm; 0 to 14 feet thick (avg. 8 feet).

Approx. Sta. 68+00 to 81+50: 2 to 10 feet thick (avg. 6 feet); U.C.= 2.5 to 4.5 tsf (avg. 4.0 tsf); underlain with clayey layers: avg 3 feet thick; U.C.= 1.5 to 3 tsf. Maximum depth to rock approx. 24 feet. See Section DD', Foundation Report.

Approx. Sta. 81+50 to 96+00: firm to dense; interbedded with CL and SC to approx. depth of 23 feet. Local loose sand layers with depth.

Approx. Sta. 96+00 to 106+50: layers 0 to 21 feet thick (avg. 8 feet); firm to dense; U.C. approx. 2.5 tsf. Patches of clay 0 to 3 feet thick (avg. 1.5 feet). Depth to rock 0 to 22 feet (avg. 7 feet).

CL-SC Predominantly clayey soils, lean clay, CL and clayey sand, SC; hardpan; firm to stiff.

Approx. Sta. 3+70 to 59+00: 0 to 6 feet thick (avg. 3 feet); U.C.= 2 to 4.5 tsf (avg. 4.0 tsf).

Approx. Sta. 63+15 to 67+00: firm to stiff; 0 to 4 feet thick (avg. 2.0 feet); underlain with firm silty sand, SM and sandy silt, ML, 0 to 13 feet thick (avg. 6 feet).

Approx. Sta. 68+00 to 81+50: surficial clay, CL; 0 to 6 feet thick (avg. 2 feet). Subsurface clay, CL, above bedrock; 1 to 15 feet thick (avg. 3 feet); U.C.= 1.5 to 4.5 tsf (avg. 3.0 tsf).

Approx. Sta. 104+00 to 108+00: clayey soils, SC; firm to stiff; hardpan. Sand, SM and SW; firm; slightly cemented.

Predominantly sand, SW-SM; silt, ML; and gravel, GP; loose; U.C.= 0 to 2.5 tsf (avg. 0.5 tsf). Borings in the vicinity of the spillway indicate N = 3 to 8 (avg. 5) for subsurface ML, SP and SW. Some cohesive subsurface layers.

Approx. Sta. 106+50 to 129+10: depth to bedrock 3 to 31 feet (avg. 21 feet).

Approx. Sta. 134+80 to 141+00: depth to bedrock 0 to 16 feet (avg. 10 feet).

Sandy clay, CL; residual soil.

Approx. Sta. 150+00 to 161+30 (end of dam): depth to bedrock 0 to 12 feet (avg. 3 feet); U.C.= 4.5 tsf.

Fat clay, CH; Scattered patches; typically 0 to 6 inches remaining; firm to hard.

Caliche: Calcium carbonate-rich zone. - Approx. Sta. 119+50 to 127+00.

LEGEND FOR EMBANKMENT AND FOUNDATION PLATES

460 / 458	Foundation Contours (10 Ft. major, 2 Ft. minor)
	Approximate Dam Footprint
⊕ 27	Survey Monument SJ-11-(n)
● P-14	Piezometer P-(n)
O 2B-2 O 2F-7 □ 4F-2 O 7F-9	Foundation and Borrow Explorations
445	Approximate pre-construction Groundwater Elevation Contours (measured from observation wells and explorations, various dates).

Notes: Original Ground contours shown outside of Foundation excavation represent pre-construction topography.

Grid coordinates refer to Calif. State Plane, Zone4; NAD '27. Elevations refer to NGVD '29.

N

GRAPHIC SCALE

500 0 500 1000 1500 Ft.

SCALE: 1" = 1000 FEET

FANCHER CREEK DAM
REDBANK AND FANCHER CREEKS FRESNO, CALIFORNIA

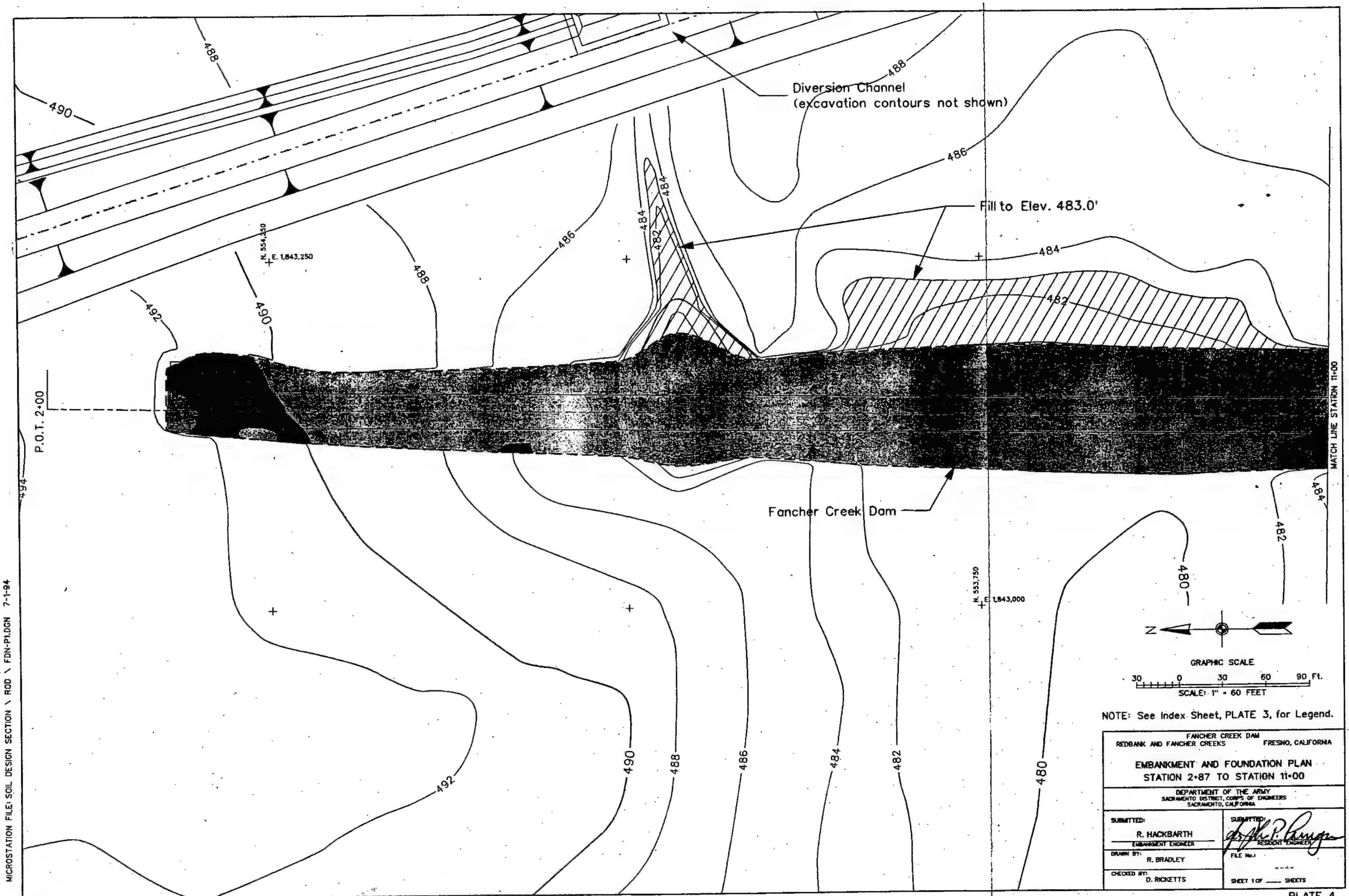
INDEX AND LEGEND TO PLATES FOR FOUNDATION AND EMBANKMENT PLAN

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SUBMITTED: R. HACKBARTH, EMBANKMENT ENGINEER
SUBMITTED: [signature] RESIDENT ENGINEER
DRAWN BY: R. BRADLEY
FILE No.:
CHECKED BY: D. RICKETTS
SHEET __ OF __ SHEETS

PLATE 3

MICROSTATION FILE: SOIL DESIGN SECTION \ ROD \ FDN-INDX.DGN 7-3-94



NOTE: See Index Sheet, PLATE 3, for Legend.

FANCHER CREEK DAM
REDBANK AND FANCHER CREEKS — FRESNO, CALIFORNIA

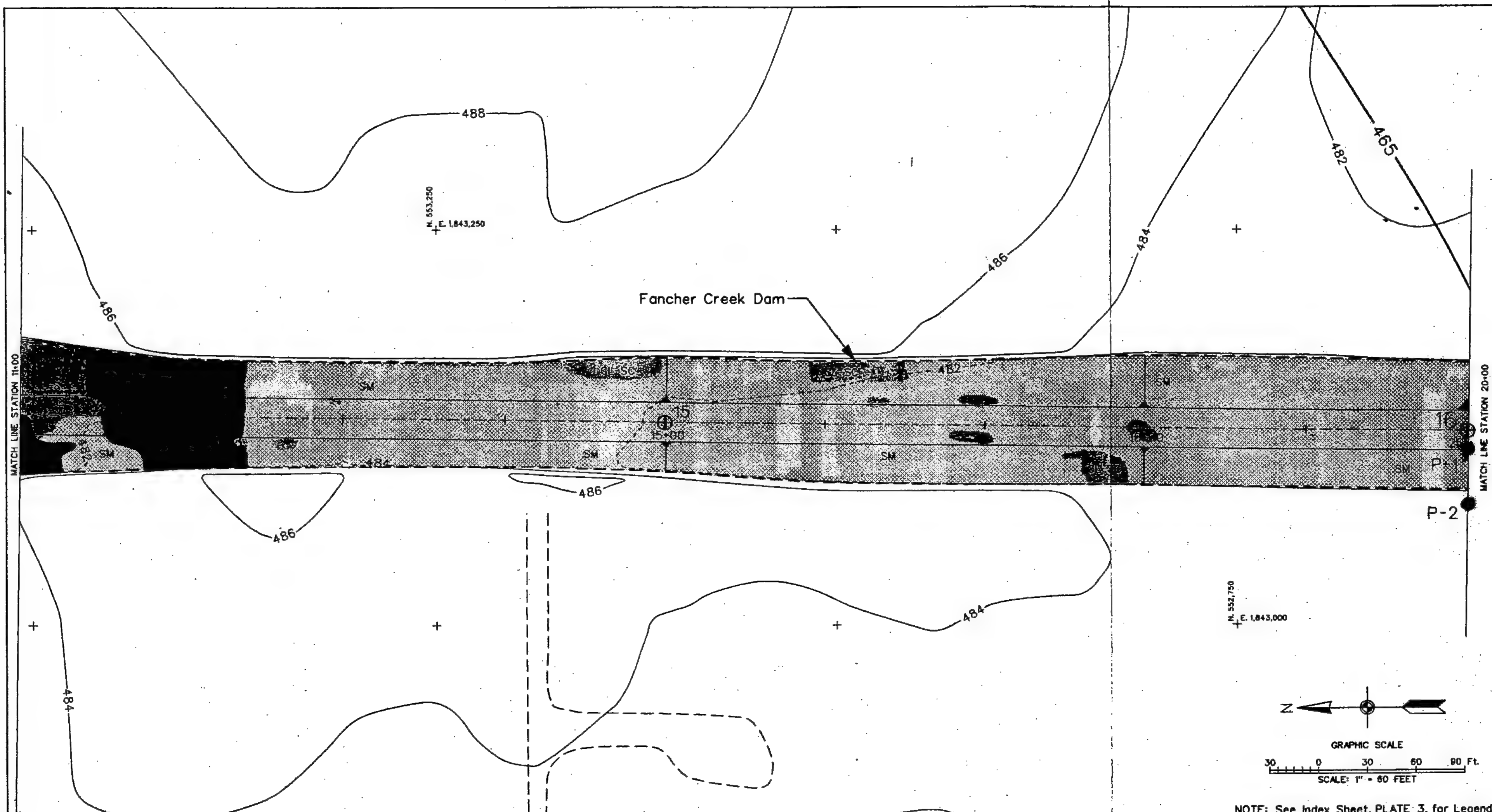
EMBANKMENT AND FOUNDATION PLAN
STATION 2+87 TO STATION 11+00

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SUBMITTED: R. HACKBARTH, EMBANKMENT ENGINEER
SUBMITTED: RESIDENT ENGINEER
DRAWN BY: R. BRADLEY
CHECKED BY: D. RICKETTS
FILE No.: ----
SHEET 1 OF ____ SHEETS

PLATE 4

MICROSTATION FILE: SOIL DESIGN SECTION \ ROD \ FDN-P1.DGN 7-1-94



NOTE: See Index Sheet, PLATE 3, for Legend.

FANCHER CREEK DAM
REDBANK AND FANCHER CREEKS FRESNO, CALIFORNIA

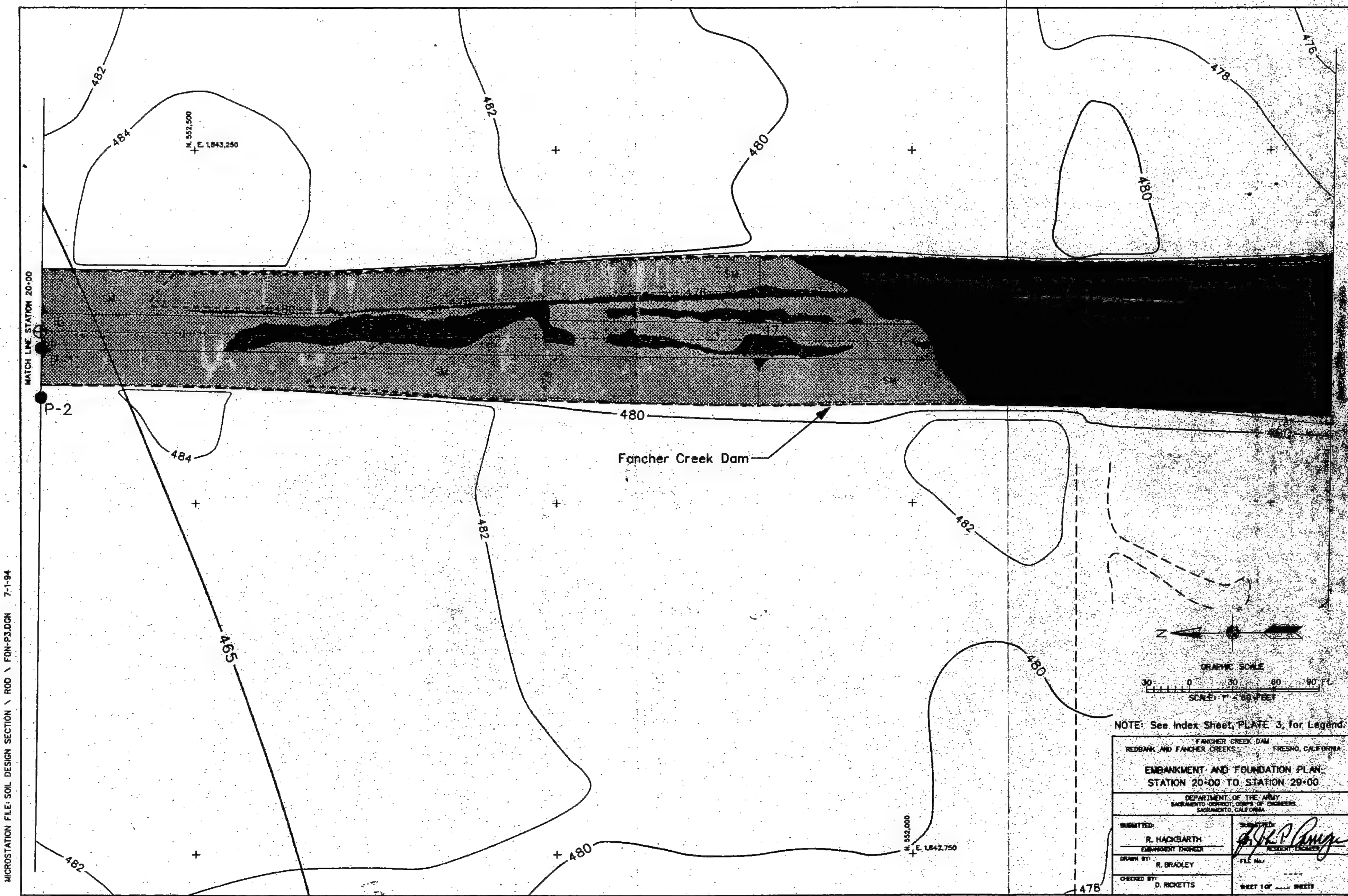
EMBANKMENT AND FOUNDATION PLAN
STATION 11+00 TO STATION 20+00

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SUBMITTED: R. HACKBARTH, EMBANKMENT ENGINEER
SUBMITTED: RESIDENT ENGINEER
DRAWN BY: R. BRADLEY
FILE No.: ----
CHECKED BY: D. RICKETTS
SHEET 1 OF ___ SHEETS

PLATE 5

MICROSTATION FILE: SOIL DESIGN SECTION \ ROD \ FON-P2.DGN 7-1-94



MICROSTATION FILE: SOIL DESIGN SECTION \ ROD \ FDN-P3.DGN 7-1-94

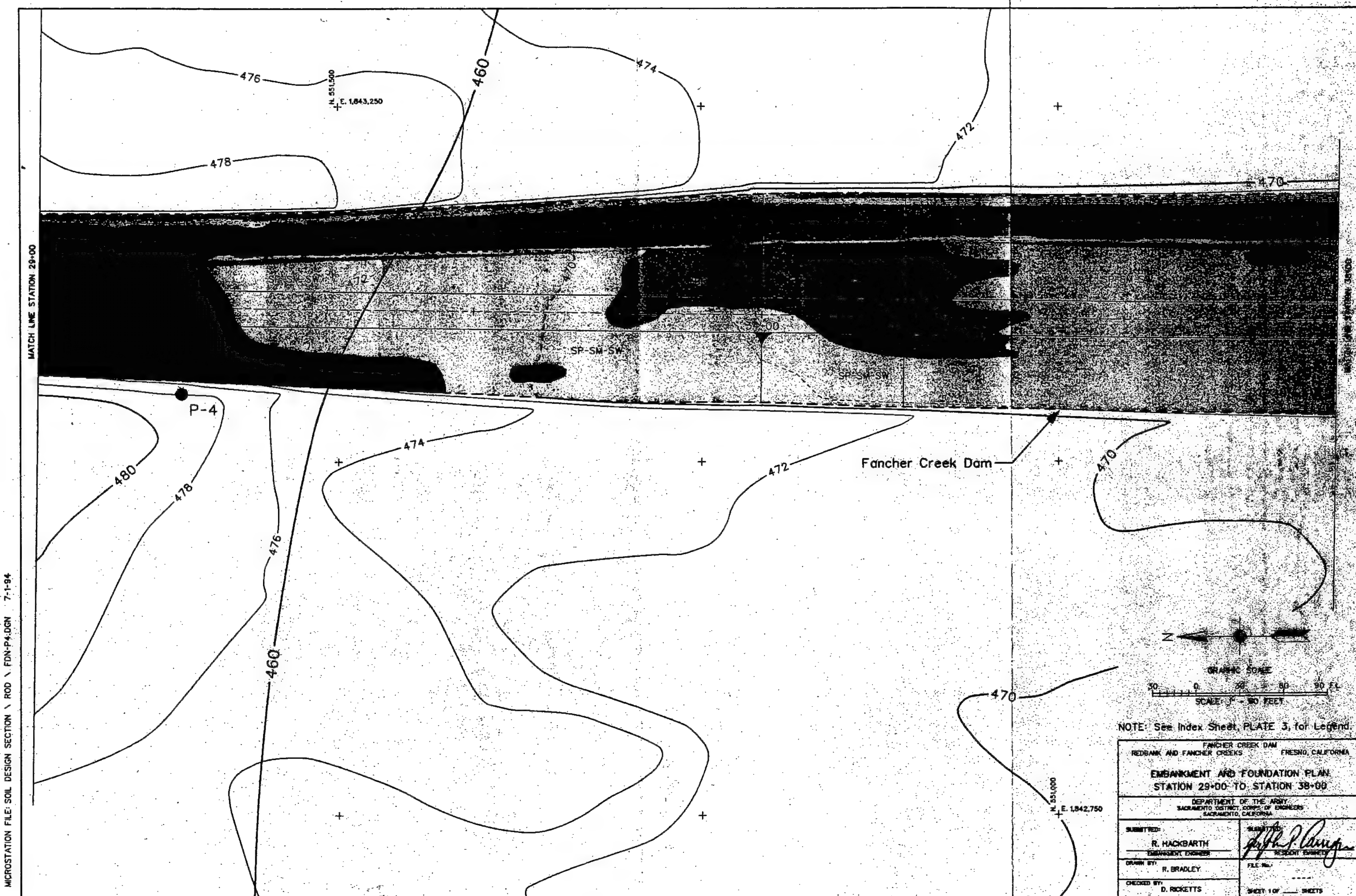
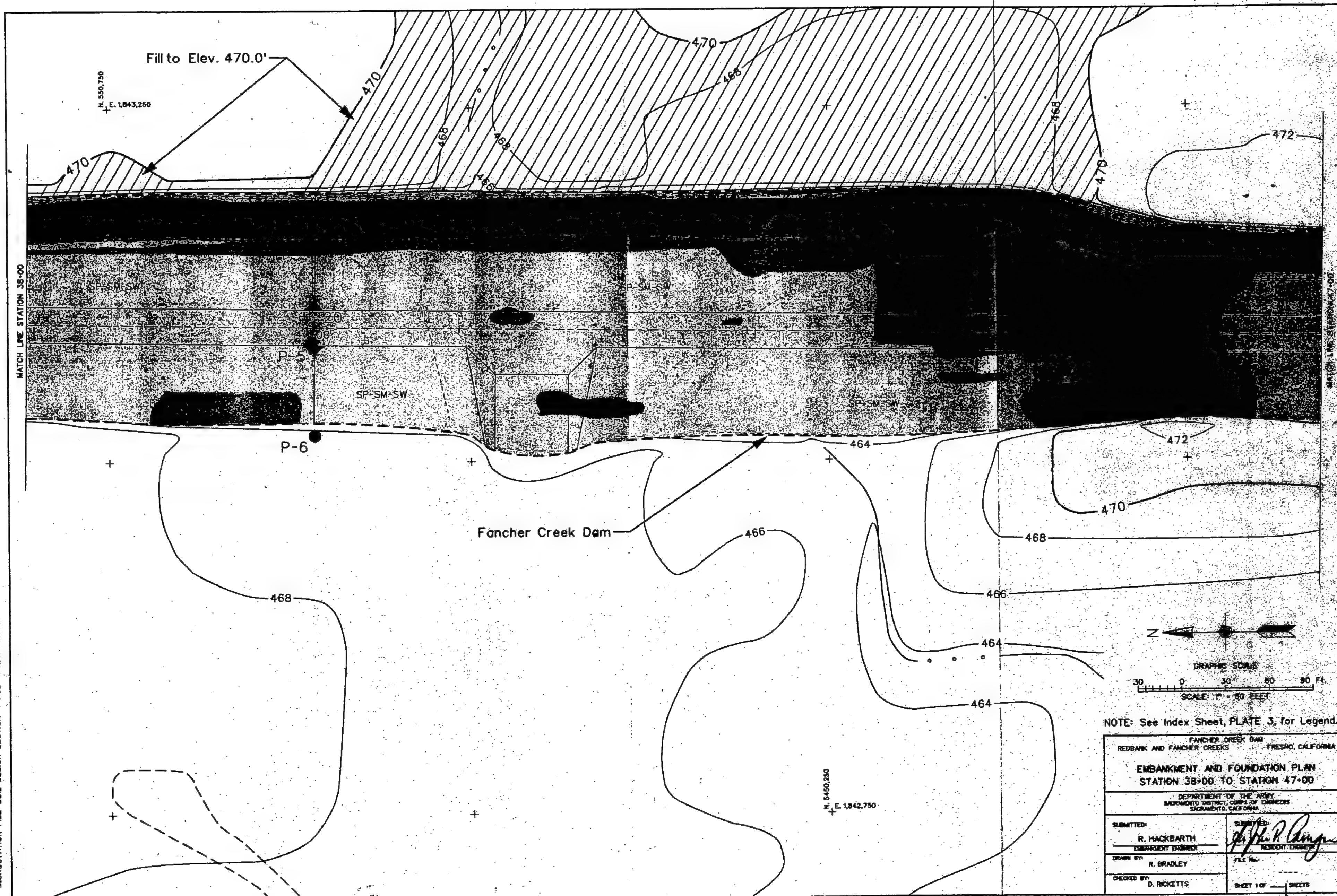


PLATE 7

MICROSTATION FILE: SOIL DESIGN SECTION \ ROD \ FDN-P4.DGN 7-1-94



NOTE: See Index Sheet, PLATE 3, for Legend.

FANCHER CREEK DAM
REDBANK AND FANCHER CREEKS FRESNO, CALIFORNIA

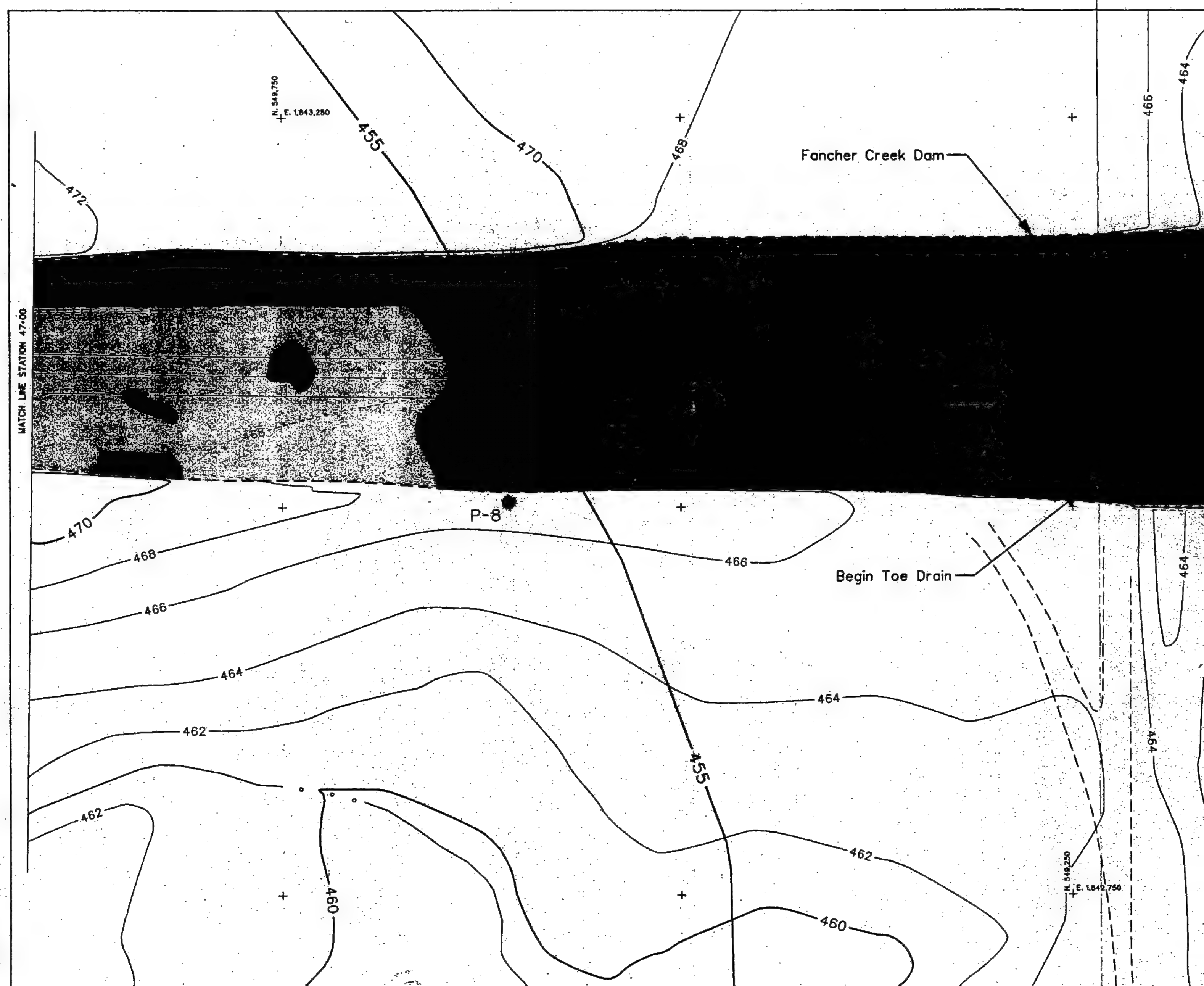
EMBANKMENT AND FOUNDATION PLAN
STATION 38+00 TO STATION 47+00

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SUBMITTED: R. HACKBARTH, EMBANKMENT ENGINEER
SUBMITTED: RESIDENT ENGINEER
DRAWN BY: R. BRADLEY
CHECKED BY: D. RICKETTS
FILE No. ----
SHEET 1 OF 1 SHEETS

PLATE 8

MICROSTATION FILE: SOIL DESIGN SECTION \ ROD \ FDN-P5.DGN 7-1-94



NOTE: See Index Sheet, PLATE 3, for Legend.

FANCHER CREEK DAM
REDBANK AND FANCHER CREEKS FRESNO, CALIFORNIA

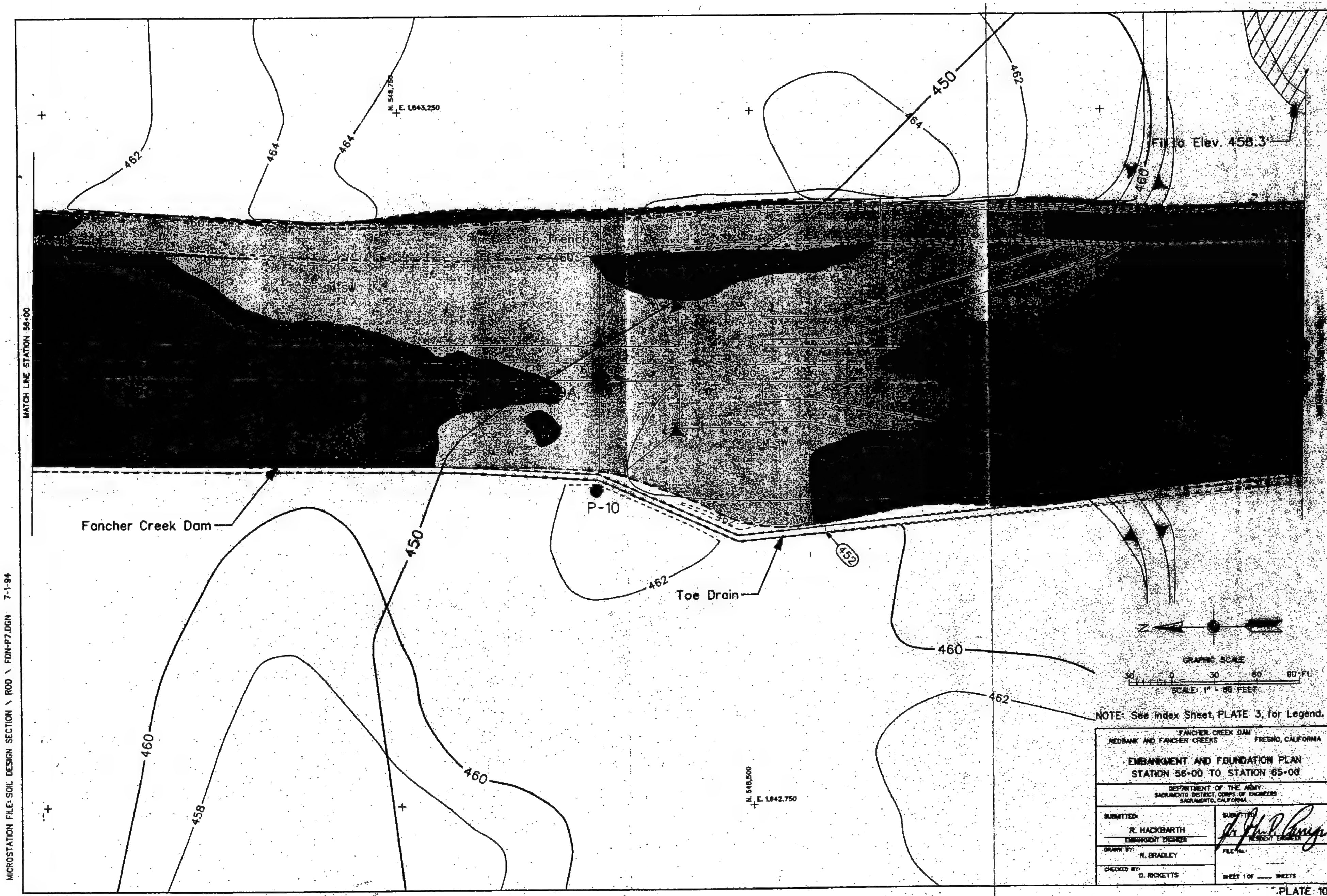
EMBANKMENT AND FOUNDATION PLAN
STATION 47+00 TO STATION 56+00

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

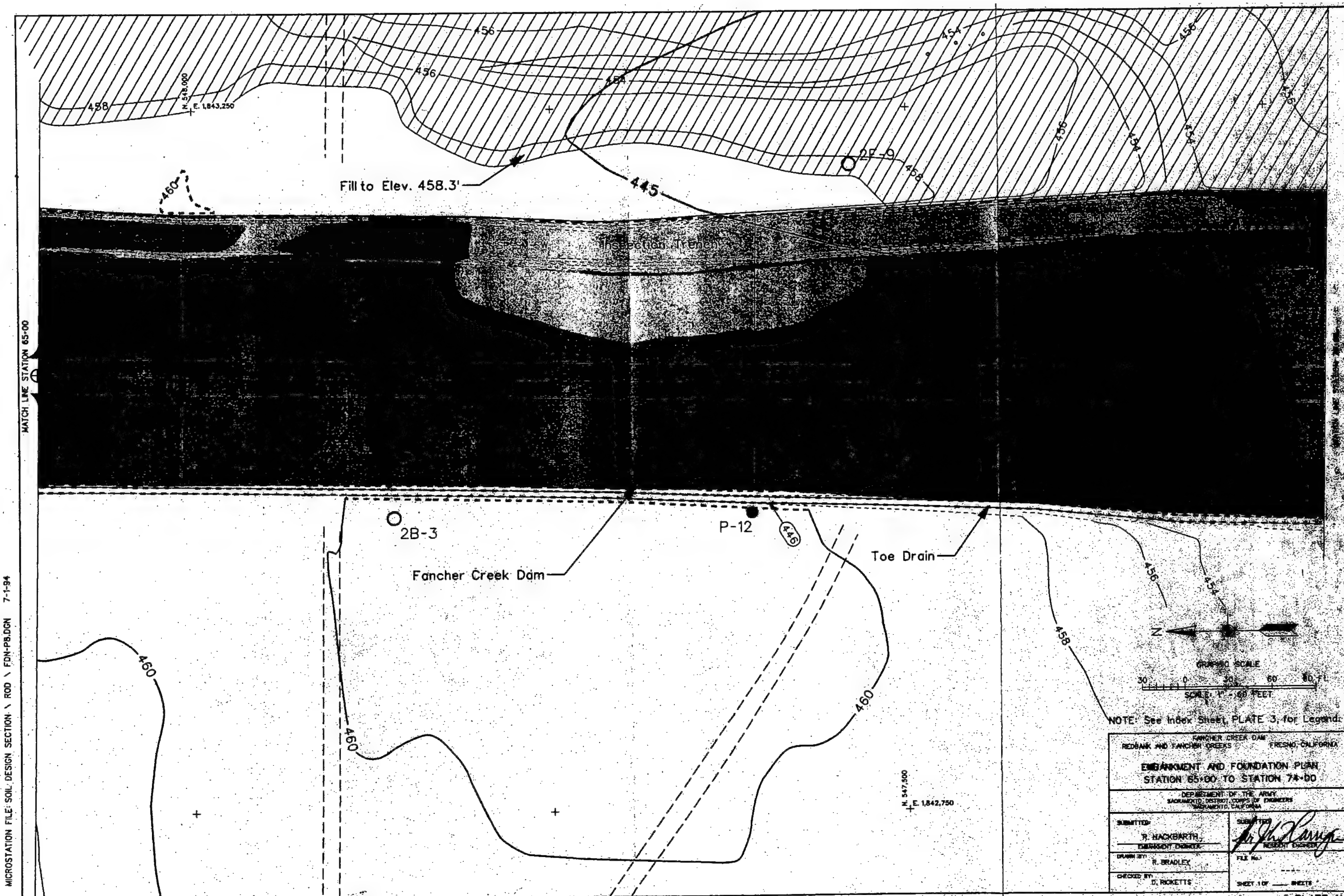
SUBMITTED: R. HACKBARTH, EMBANKMENT ENGINEER
SUBMITTED: RESIDENT ENGINEER
DRAWN BY: R. BRADLEY
CHECKED BY: D. RICKETTS
FILE No.
SHEET 1 OF ___ SHEETS

MICROSTATION FILE: SOIL DESIGN SECTION \ ROD \ FDN-P6.DGN 7-1-94

PLATE 9



MICROSTATION FILE: SOIL DESIGN SECTION \ ROD \ FDN-P7.DGN 7-1-94



NOTE: See Index Sheet, PLATE 3, for Legend.

FANCHER CREEK DAM
REDBANK AND FANCHER CREEKS — FRESNO, CALIFORNIA

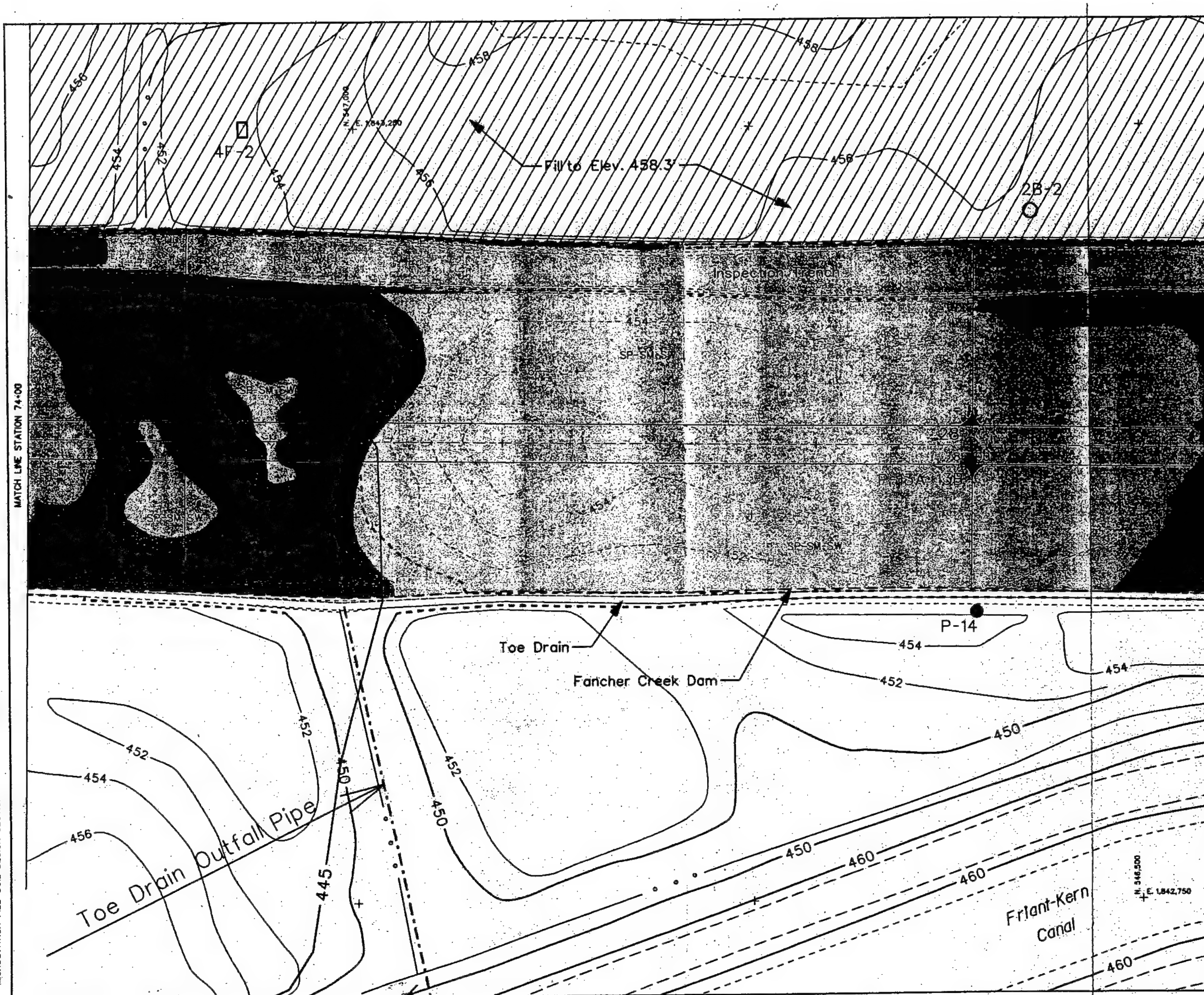
EMBANKMENT AND FOUNDATION PLAN
STATION 65+00 TO STATION 74+00

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SUBMITTED: R. HACKBARTH, EMBANKMENT ENGINEER
DRAWN BY: R. BRADLEY
CHECKED BY: D. RICKETTS
SUBMITTED: RESIDENT ENGINEER
FILE No.
SHEET 1 OF ___ SHEETS

PLATE 11

MICROSTATION FILE: SOIL DESIGN SECTION \ ROD \ FDN-P8.DGN 7-1-94



NOTE: See Index Sheet, PLATE 3, for Legend.

FANCHER CREEK DAM
REDBANK AND FANCHER CREEKS FRESNO, CALIFORNIA

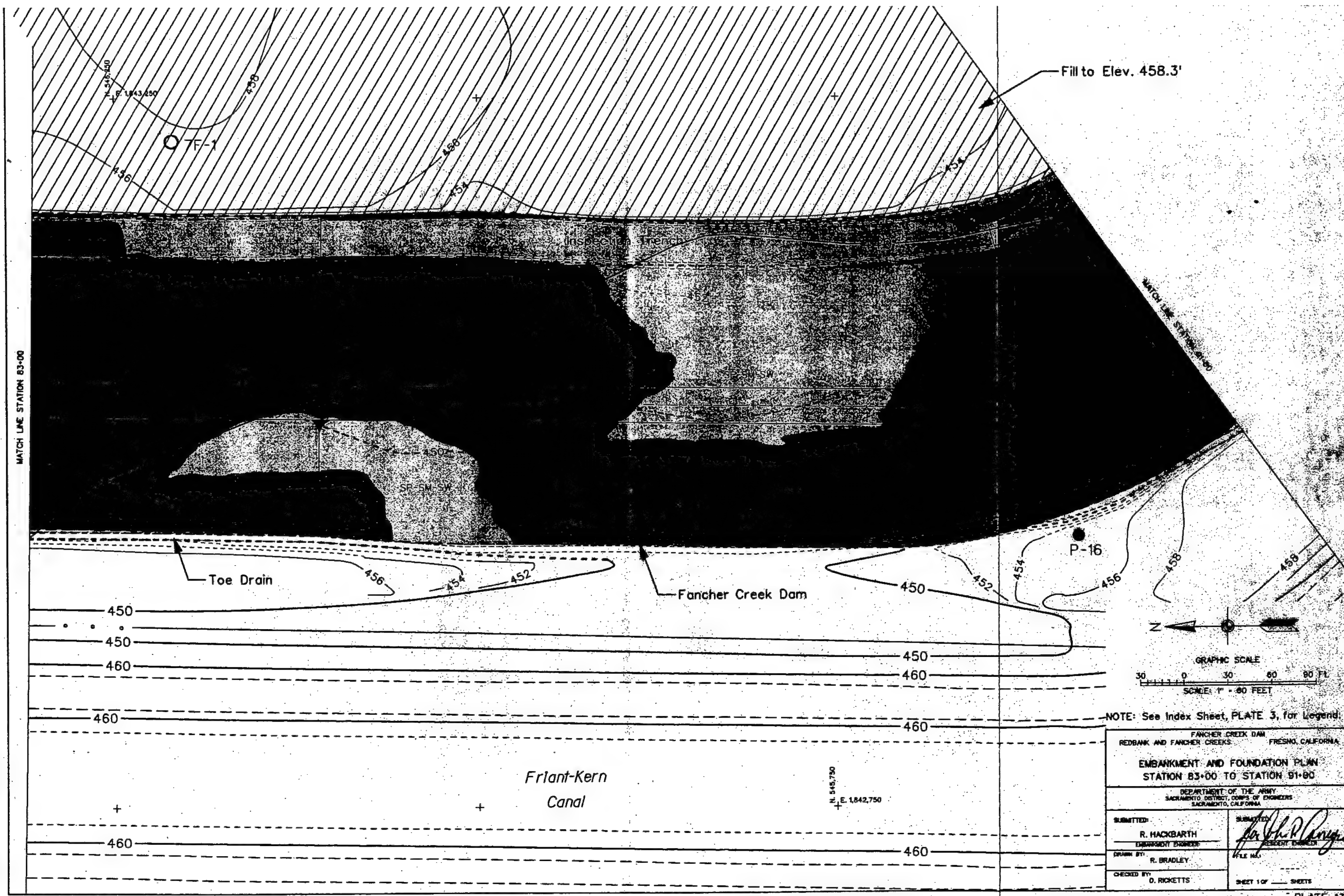
EMBANKMENT AND FOUNDATION PLAN
STATION 74+00 TO STATION 83+00

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

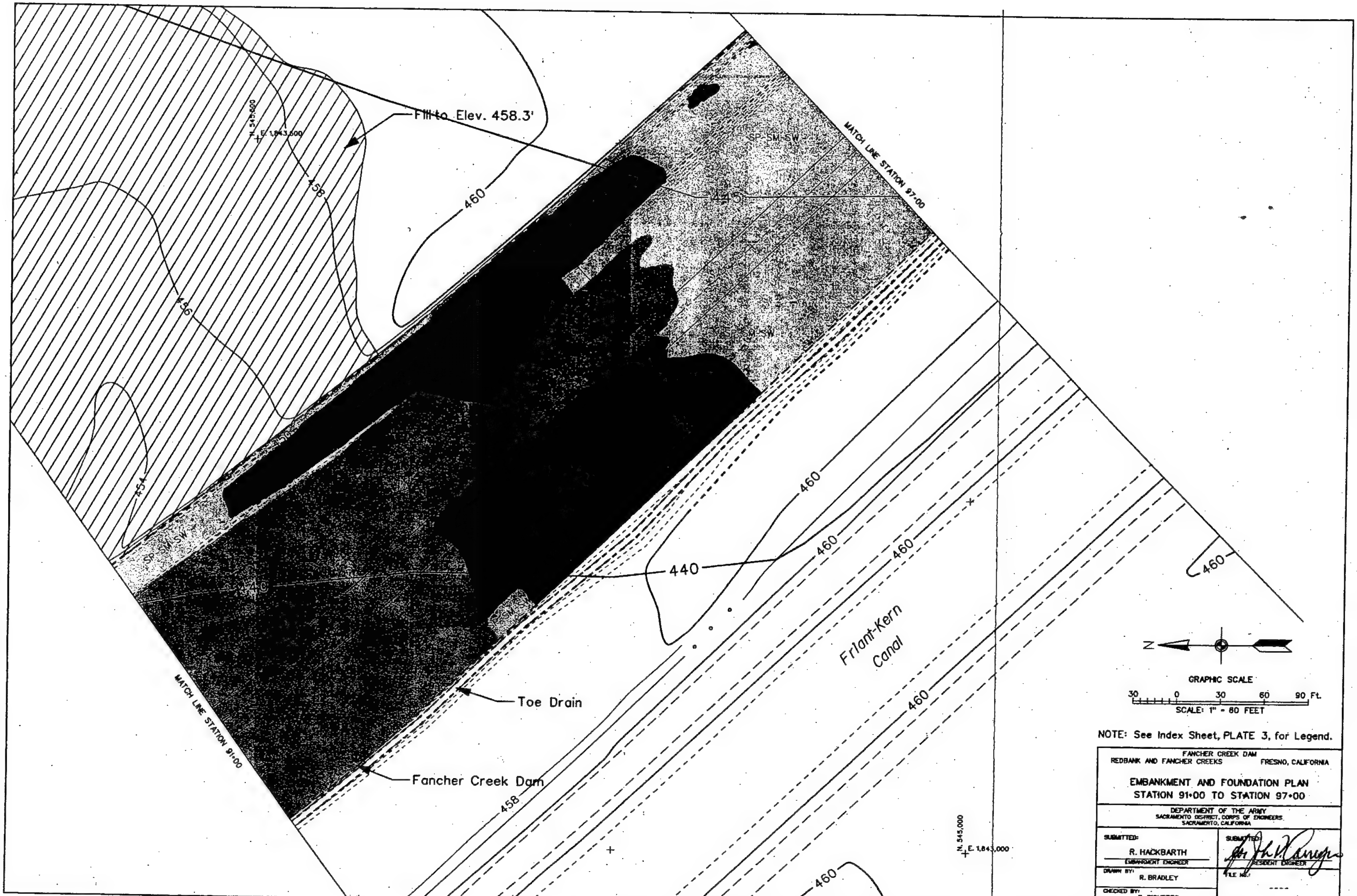
SUBMITTED: R. HACKBARTH, EMBANKMENT ENGINEER	SUBMITTED: RESIDENT ENGINEER
DRAWN BY: R. BRADLEY	FILE No.:
CHECKED BY: D. RICKETTS	SHEET 1 OF ___ SHEETS

PLATE 12

MICROSTATION FILE: SOIL DESIGN SECTION \ ROD \ FDN-P9.DGN 7-2-94



MICROSTATION FILE: SOIL DESIGN SECTION \ ROD \ FDN-P10.DGN 7-2-94



NOTE: See Index Sheet, PLATE 3, for Legend.

FANCHER CREEK DAM
REDBANK AND FANCHER CREEKS FRESNO, CALIFORNIA

EMBANKMENT AND FOUNDATION PLAN
STATION 91+00 TO STATION 97+00

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SUBMITTED: R. HACKBARTH, EMBANKMENT ENGINEER	SUBMITTED: RESIDENT ENGINEER
DRAWN BY: R. BRADLEY	FILE NO.: ----
CHECKED BY: D. RICKETTS	SHEET 1 OF ___ SHEETS

PLATE 14

MICROSTATION FILE: SOIL DESIGN SECTION \ ROD \ FDN-P11.DGN 7-2-94

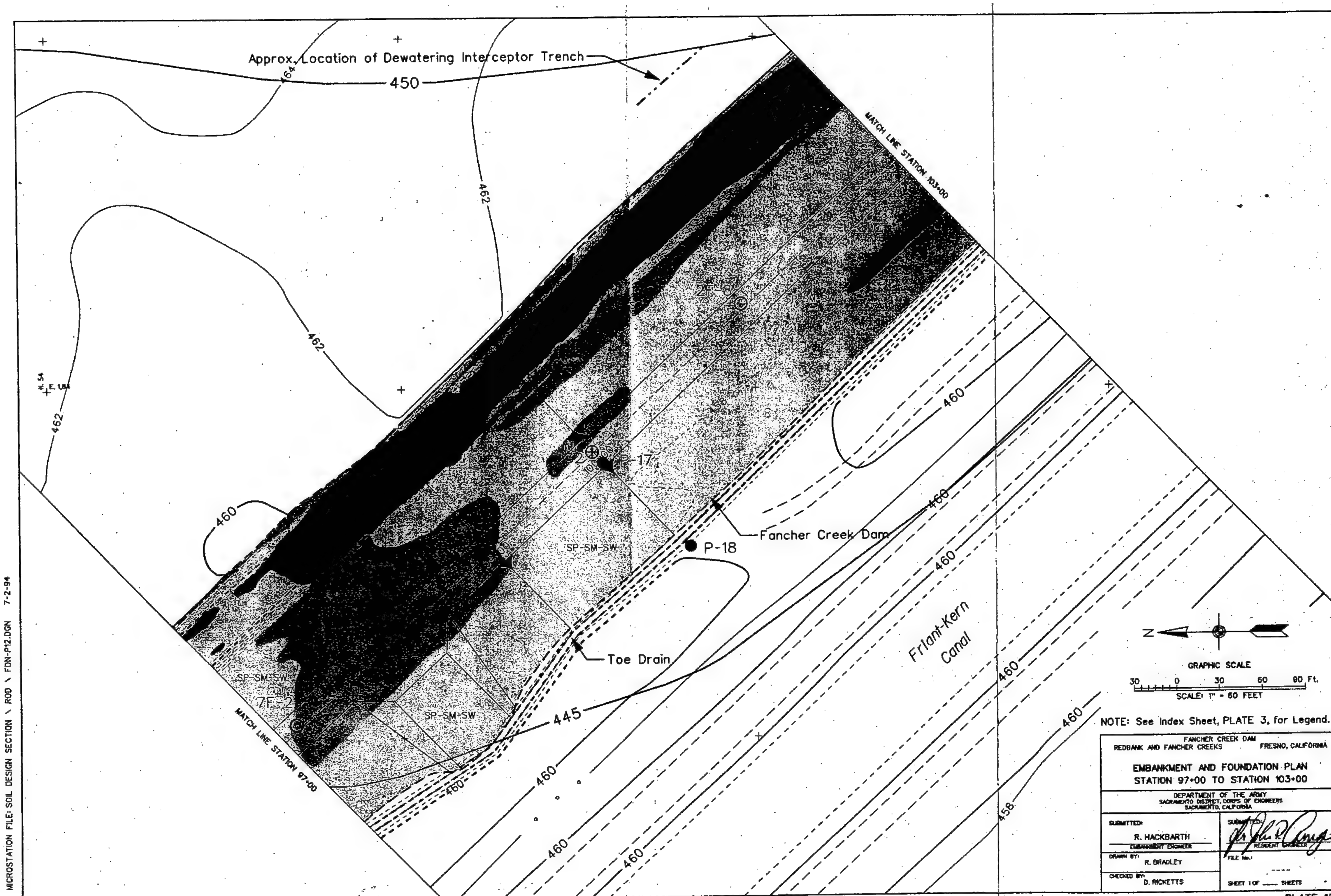
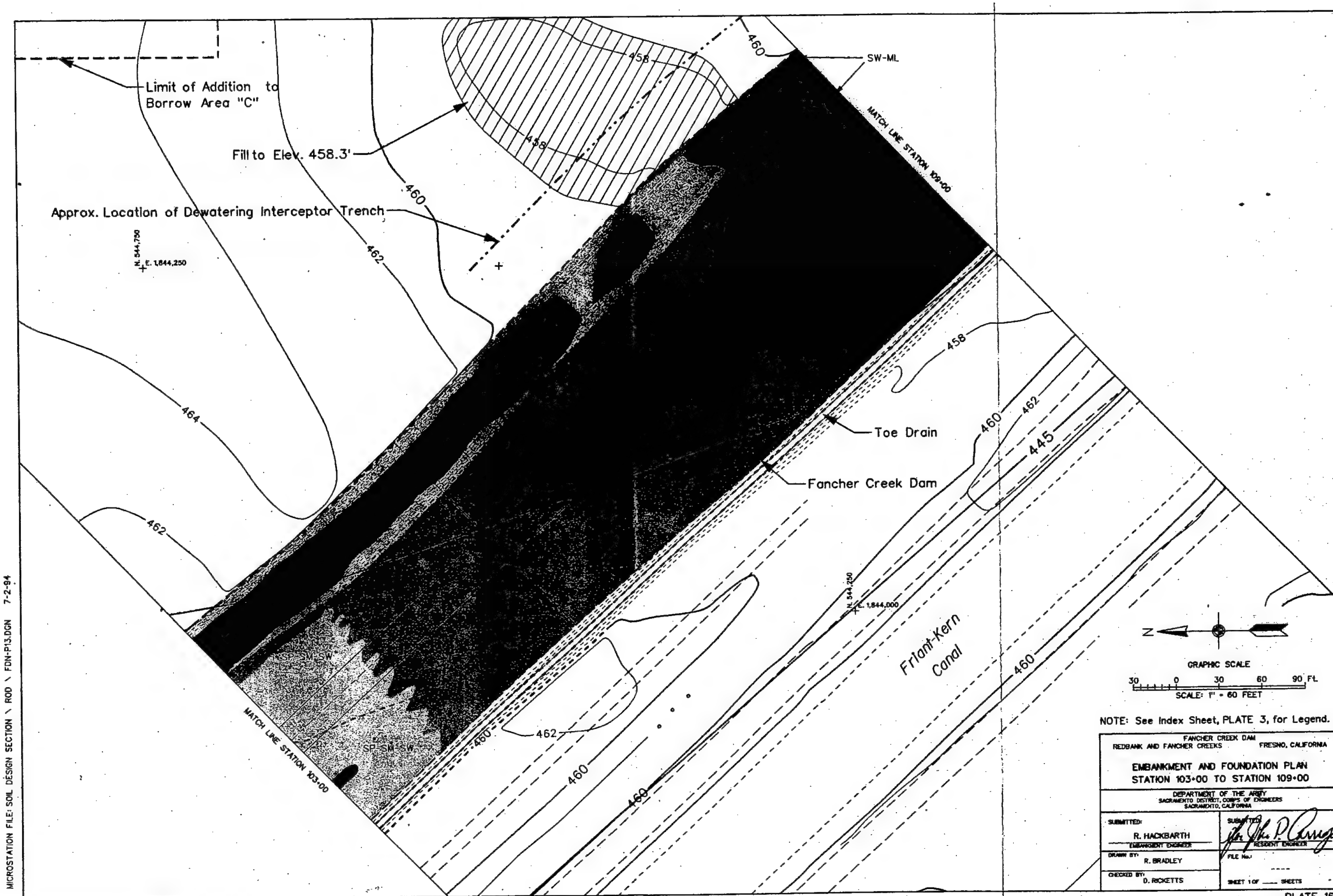
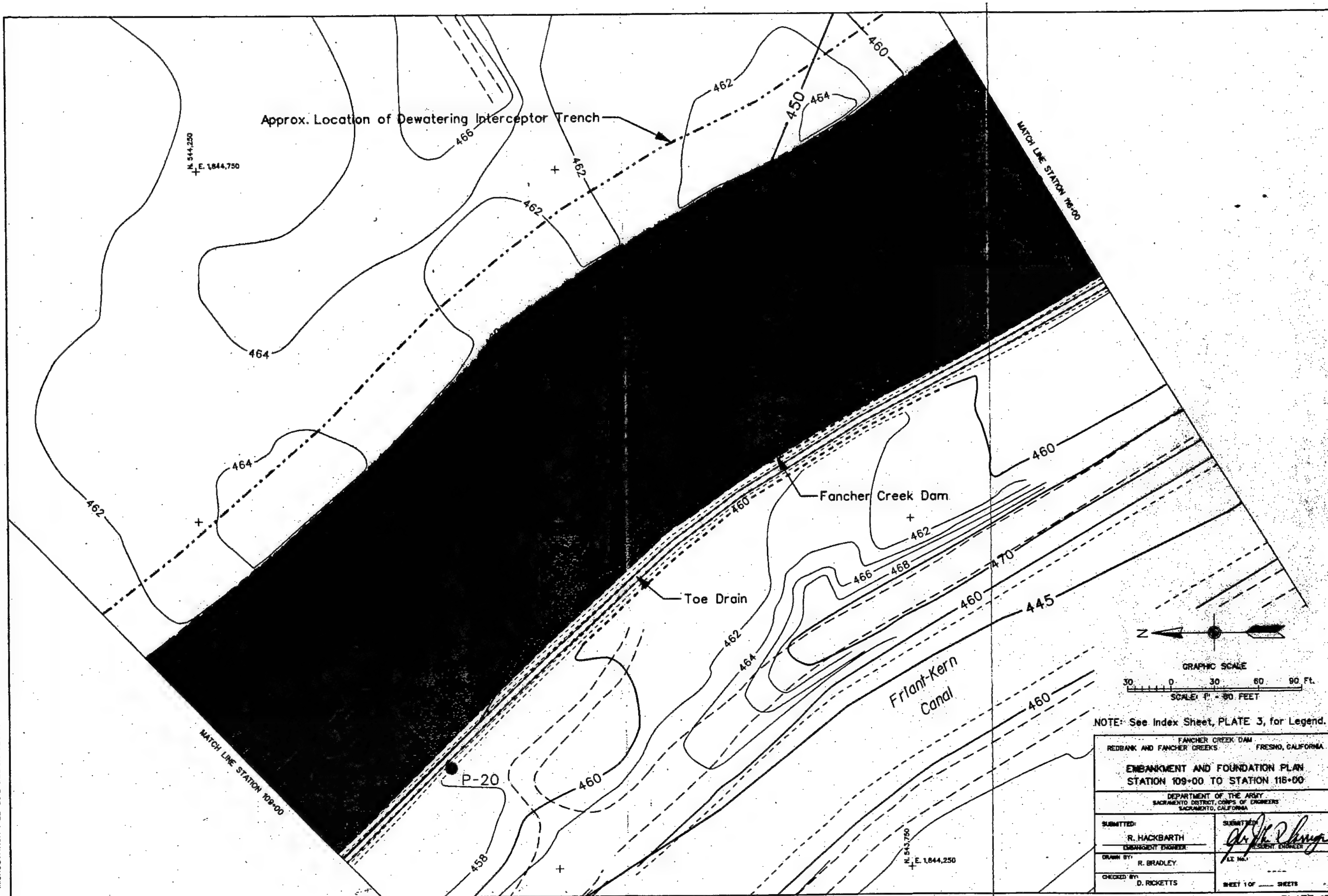


PLATE 15

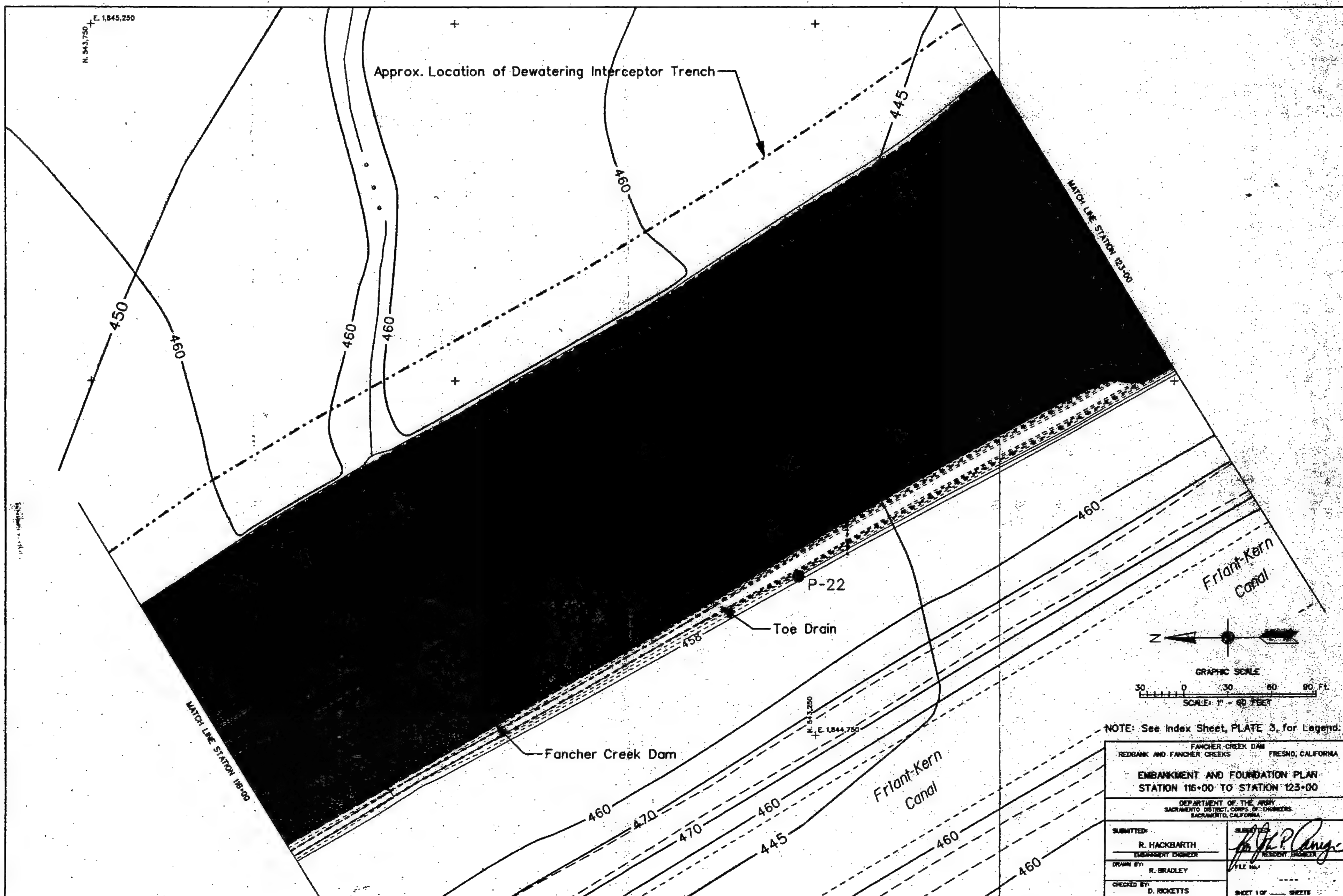
MICROSTATION FILE: SOIL DESIGN SECTION \ ROD \ FDN-P12.DGN 7-2-94



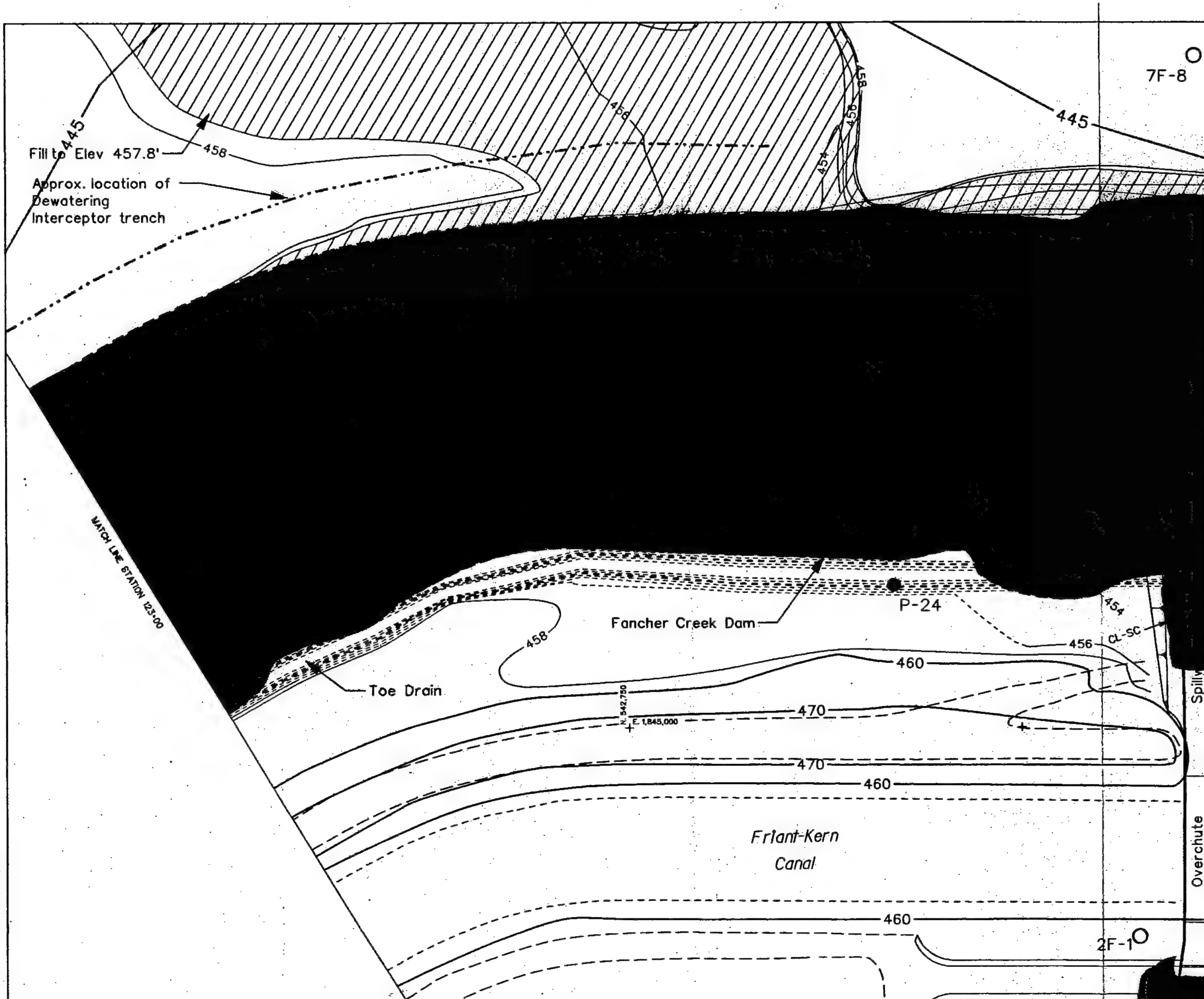
MICROSTATION FILE: SOIL DESIGN SECTION \ ROD \ FDN-P13.DGN 7-2-94



MICROSTATION FILE: SOIL DESIGN SECTION \ ROD \ FDN-P14.DGN 7-2-94



MICROSTATION FILE: SOIL DESIGN SECTION \ ROD \ FDN-P15.DGN 7-2-94



NOTE: See Index Sheet, PLATE 3, for Legend.

FANCHER CREEK DAM
REDBANK AND FANCHER CREEKS FRESNO, CALIFORNIA

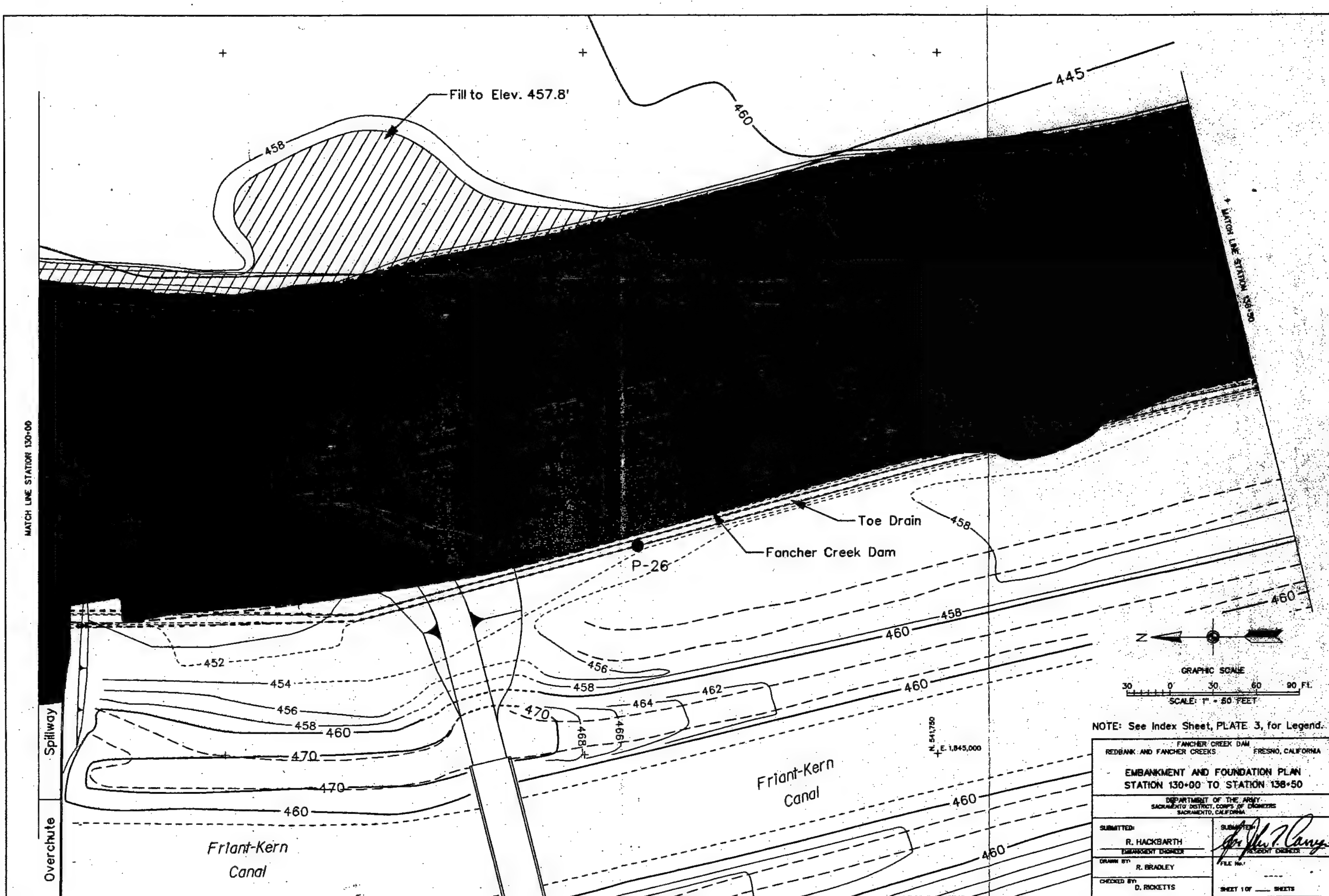
EMBANKMENT AND FOUNDATION PLAN
STATION 123+00 TO STATION 130+00

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SUBMITTED: R. HACKBARTH, EMBANKMENT ENGINEER	SUBMITTED: RESIDENT ENGINEER
DRAWN BY: R. BRADLEY	FILE No. ----
CHECKED BY: D. RICKETTS	SHEET 1 OF ___ SHEETS

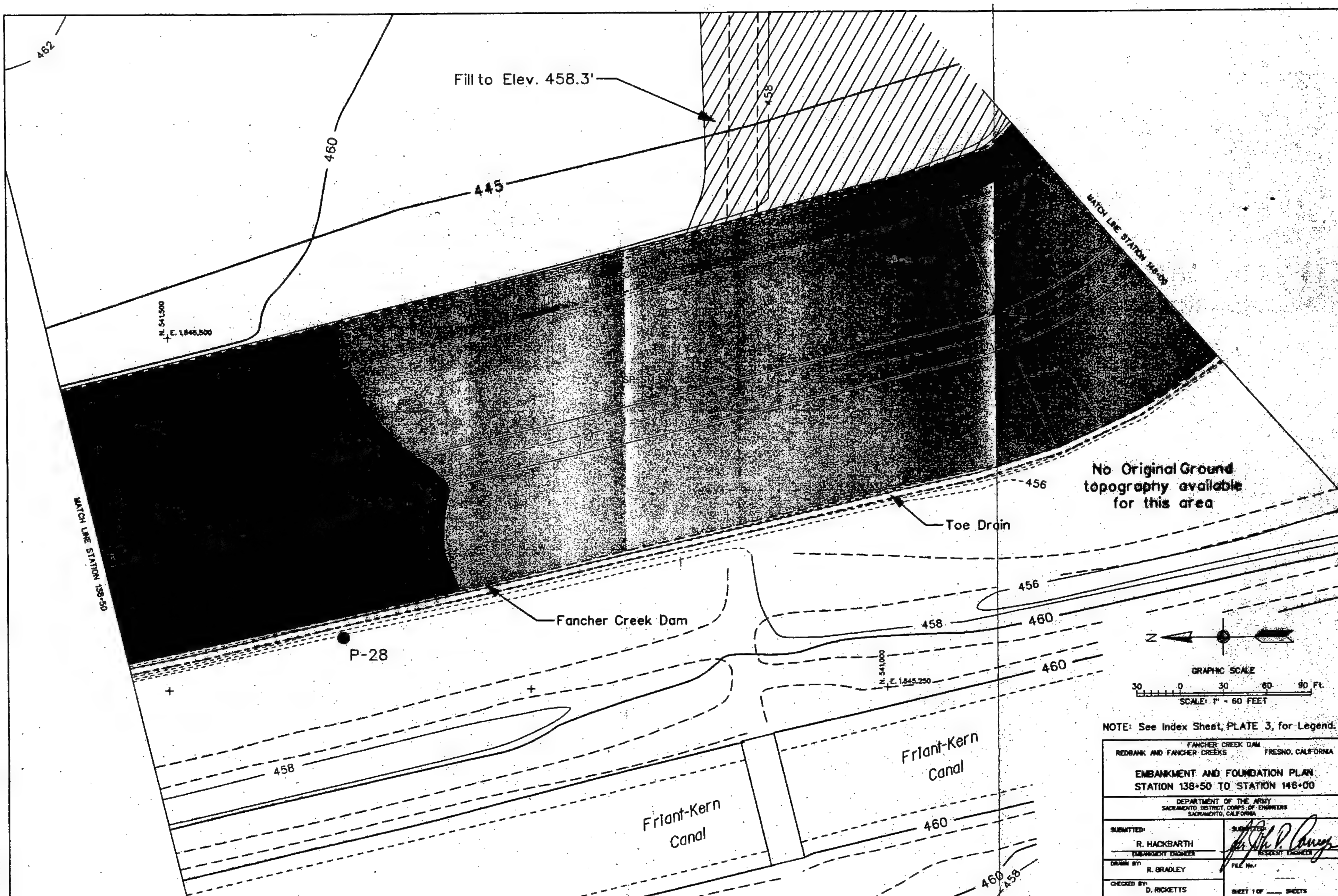
- PLATE 19

MICROSTATION FILE: SOIL DESIGN SECTION \ ROD \ FDN-P16.DGN 7-3-94



- PLATE 20

MICROSTATION FILE: SOIL DESIGN SECTION \ ROD \ FDN-P17.DGN 7-3-94



NOTE: See Index Sheet, PLATE 3, for Legend.

FANCHER CREEK DAM
REDBANK AND FANCHER CREEKS — FRESNO, CALIFORNIA

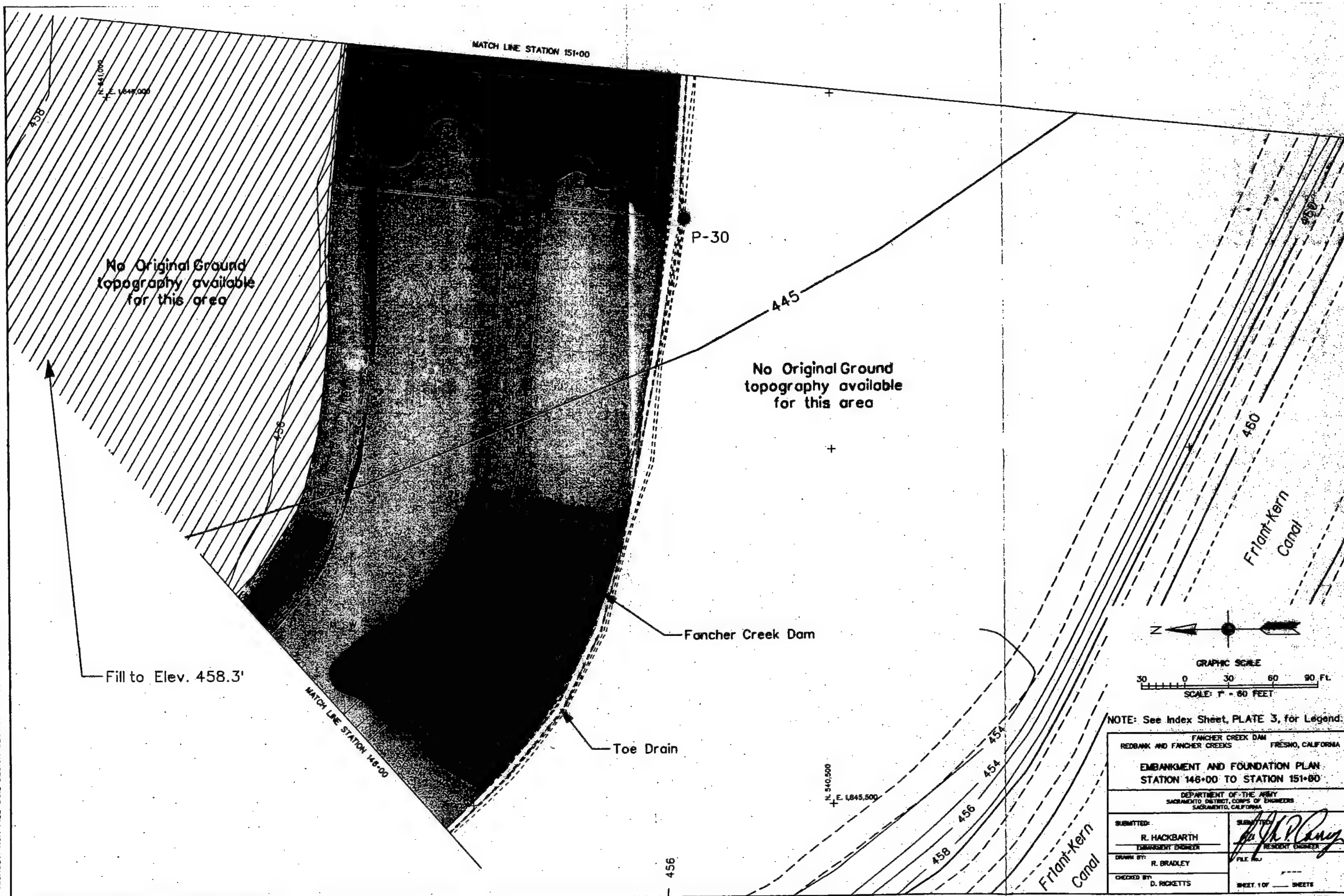
EMBANKMENT AND FOUNDATION PLAN
STATION 138+50 TO STATION 146+00

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SUBMITTED: R. HACKBARTH, EMBANKMENT ENGINEER	SUBMITTED: RESIDENT ENGINEER
DRAWN BY: R. BRADLEY	FILE No.:
CHECKED BY: D. RICKETTS	SHEET 1 OF ___ SHEETS

- PLATE 21

MICROSTATION FILE: SOIL DESIGN SECTION \ ROD \ FDN-P18.DGN 7-3-94



NOTE: See Index Sheet, PLATE 3, for Legend.

FANCHER CREEK DAM
REDBANK AND FANCHER CREEKS FRESNO, CALIFORNIA

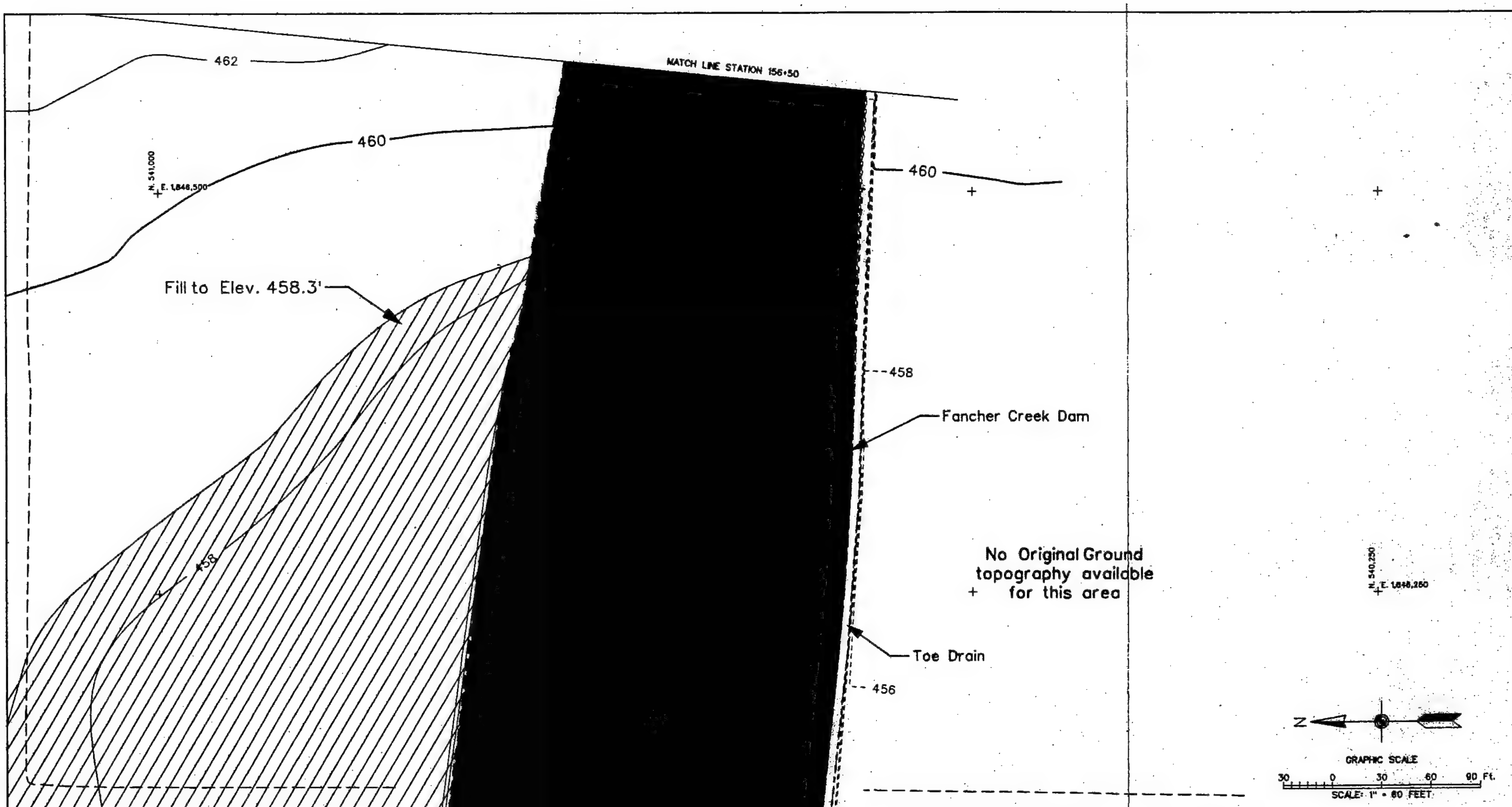
EMBANKMENT AND FOUNDATION PLAN
STATION 146+00 TO STATION 151+80

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SUBMITTED: R. HACKBARTH, EMBANKMENT ENGINEER	SUBMITTED: RESIDENT ENGINEER
DRAWN BY: R. BRADLEY	FILE NO.
CHECKED BY: D. RICKETTS	SHEET 1 OF ___ SHEETS

PLATE 22

MICROSTATION FILE: SOIL DESIGN SECTION \ ROD \ FDN-P19.DGN 7-3-94



NOTE: See Index Sheet, PLATE 3, for Legend.

FANCHER CREEK DAM
REDBANK AND FANCHER CREEKS FRESNO, CALIFORNIA

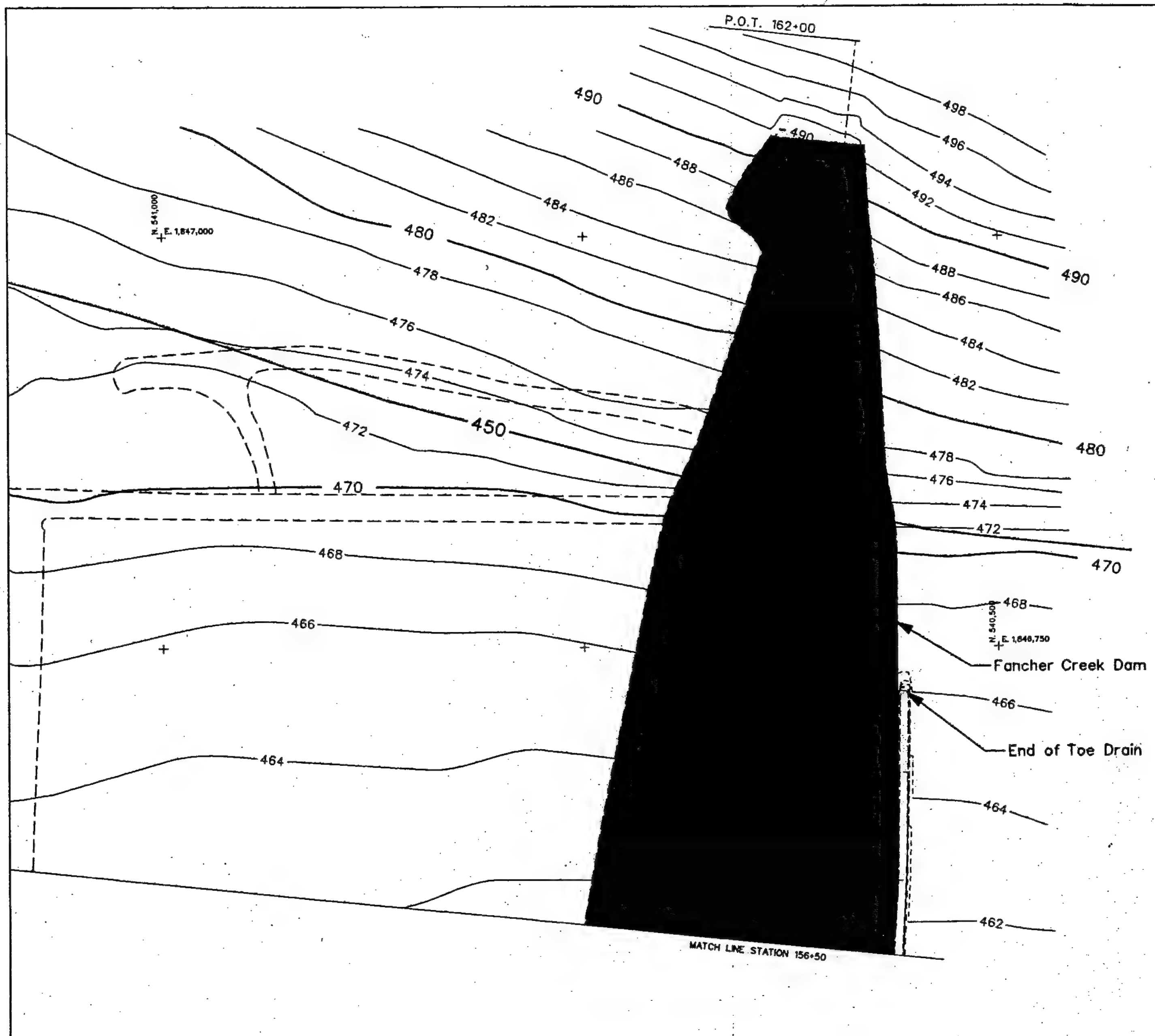
EMBANKMENT AND FOUNDATION PLAN
STATION 151+00 TO STATION 156+50

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SUBMITTED: R. HACKBARTH, EMBANKMENT ENGINEER	SUBMITTED: RESIDENT ENGINEER
DRAWN BY: R. BRADLEY	FILE No.: ----
CHECKED BY: D. RICKETTS	SHEET 1 OF ___ SHEETS

PLATE 23

MICROSTATION FILE: SOIL DESIGN SECTION \ ROD \ FDN-P20.DGN 7-3-94



N

GRAPHIC SCALE

30 0 30 60 90 Ft.

SCALE: 1" = 60 FEET

NOTE: See Index Sheet, PLATE 3, for Legend.

FANCHER CREEK DAM
REDBANK AND FANCHER CREEKS FRESNO, CALIFORNIA

EMBANKMENT AND FOUNDATION PLAN
STATION 156+50 TO STATION 162+00

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SUBMITTED: R. HACKBARTH, EMBANKMENT ENGINEER

SUBMITTED: RESIDENT ENGINEER

DRAWN BY: R. BRADLEY

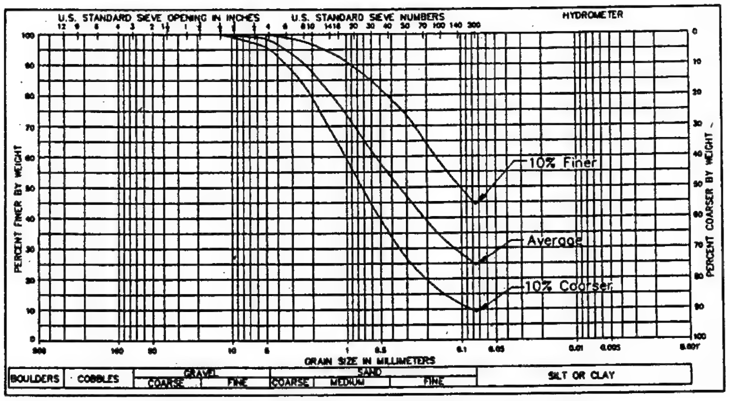
FILE No.: ----

CHECKED BY: D. RICKETTS

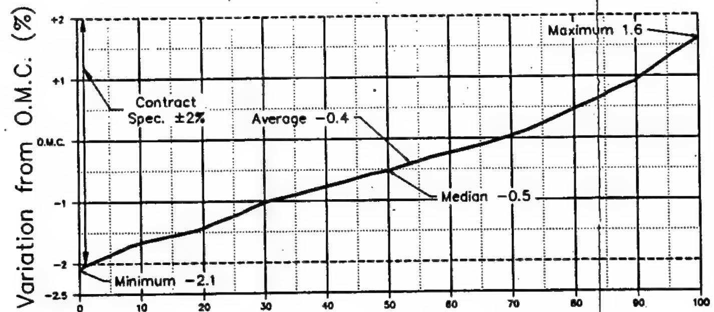
SHEET 1 OF ___ SHEETS

PLATE 24

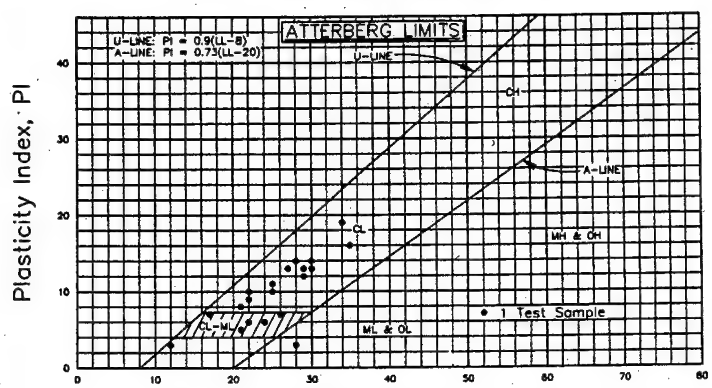
MICROSTATION FILE: SOIL DESIGN SECTION \ ROD \ FDN-P21.DGN 7-3-94



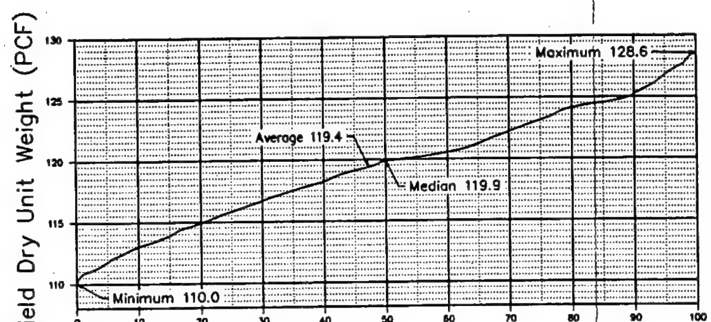
73 Tests from 12 September 1990 through 11 January 1991



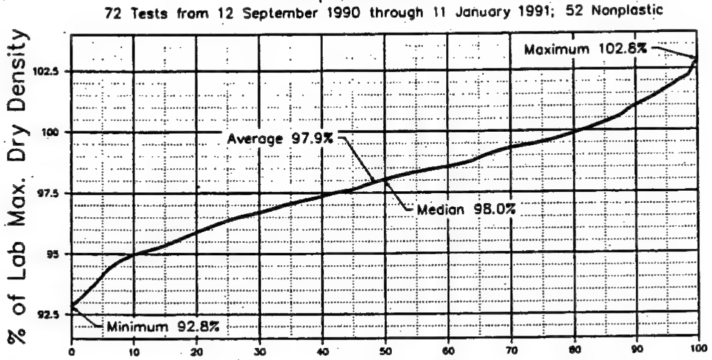
Percent of Tests with Less Moisture
264 Tests from 12 September 1990 through 11 January 1991



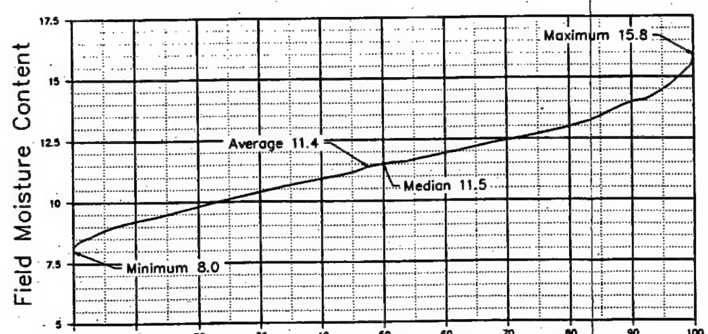
Liquid Limit, LL
72 Tests from 12 September 1990 through 11 January 1991; 52 Nonplastic



Percent of Tests with Lower Unit Weight
264 Tests from 12 September 1990 through 11 January 1991



Percent of Field Tests with Lower Density
264 Tests from 12 September 1990 through 11 January 1991

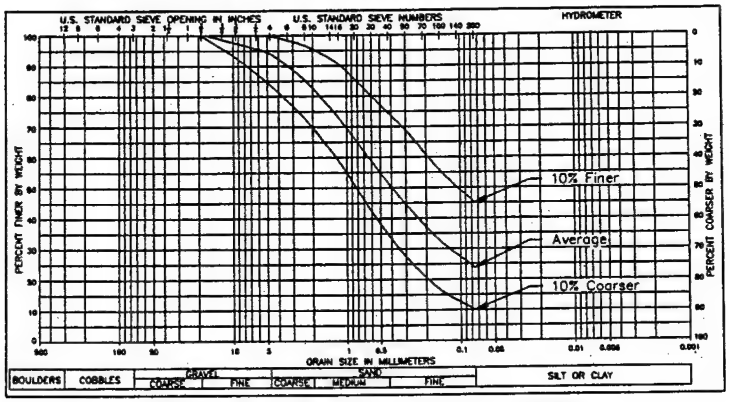


Percent of Tests with Less Moisture
264 Tests from 12 September 1990 through 11 January 1991

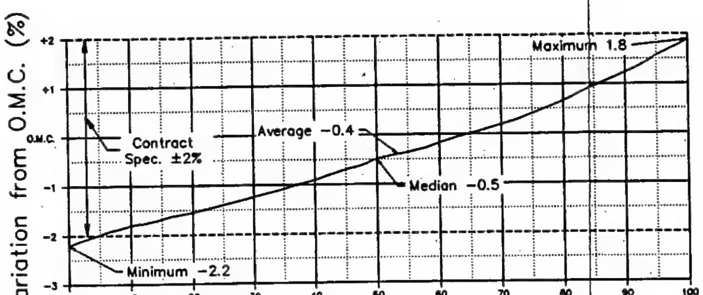
FANCHER CREEK DAM
REDBANK AND FANCHER CREEKS FRESNO, CALIFORNIA
SUMMARY OF FIELD TEST RESULTS
INSPECTION TRENCH
DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SUBMITTED: R. HACKBARTH, EMBANKMENT ENGINEER
SUBMITTED: RESIDENT ENGINEER
DRAWN BY: R. BRADLEY
CHECKED BY: D. RICKETTS
FILE NO.: ----
SHEET __ OF __ SHEETS

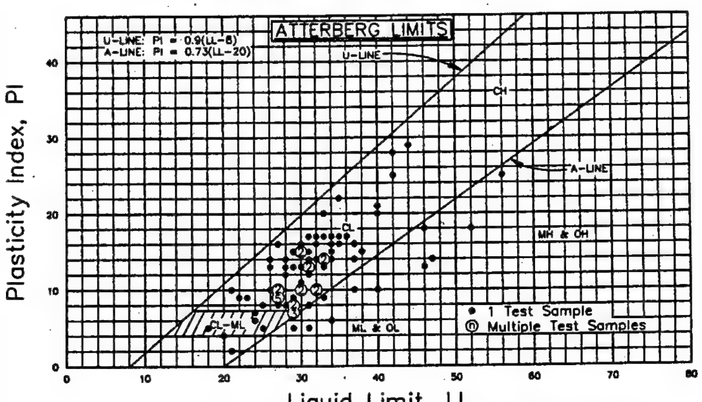
PLATE 25



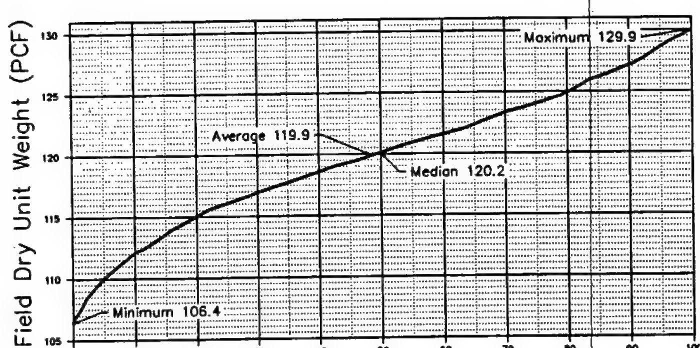
312 Tests from 17 September 1990 through 30 April 1991



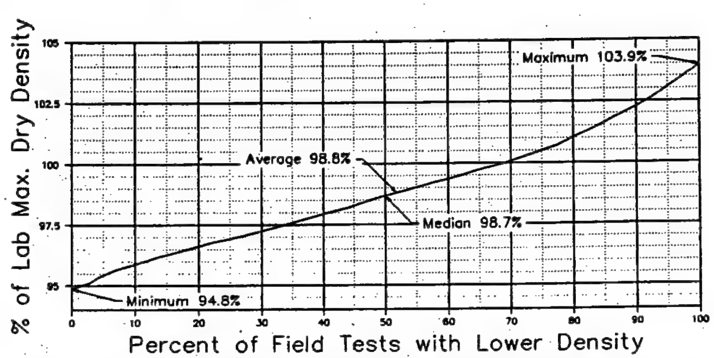
874 Tests from 17 September 1990 through 30 April 1991



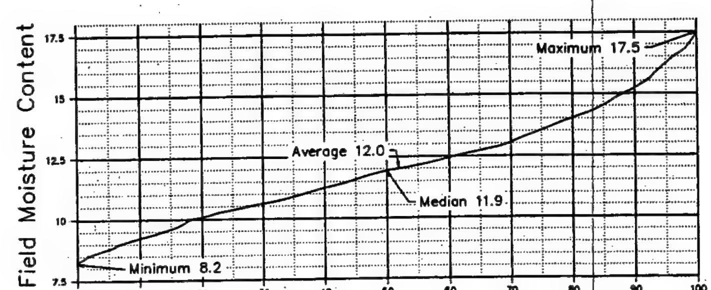
311 Tests from 17 September 1990 through 30 April 1991; 226 Nonplastic



874 Tests from 17 September 1990 through 30 April 1991



874 Tests from 17 September 1990 through 30 April 1991



874 Tests from 17 September 1990 through 30 April 1991

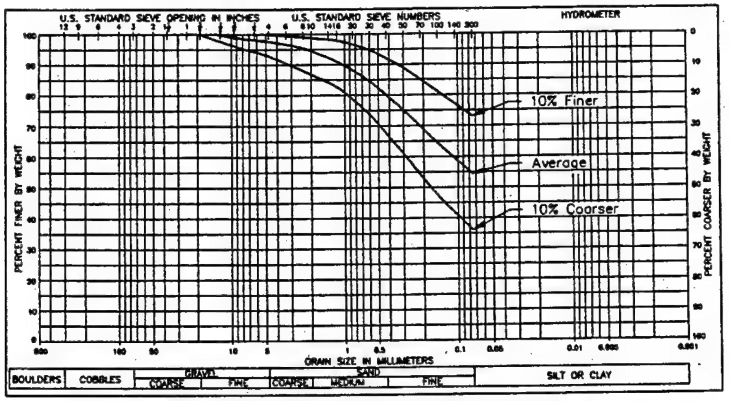
FANCHER CREEK DAM
REDBANK AND FANCHER CREEKS FRESNO, CALIFORNIA

SUMMARY OF FIELD TEST RESULTS
EMBANKMENT RANDOM FILL

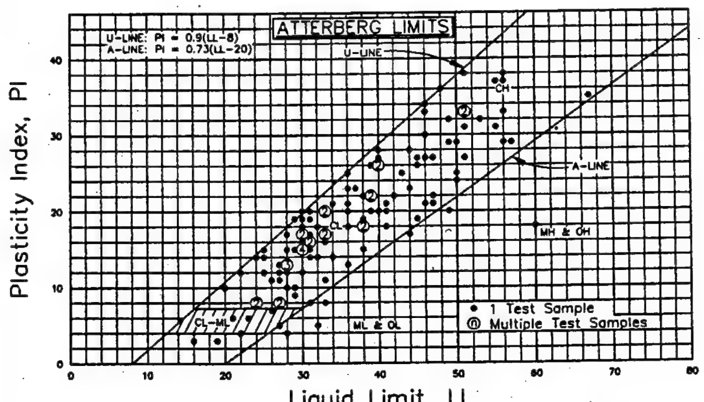
DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SUBMITTED: R. HACKBARTH, EMBANKMENT ENGINEER
SUBMITTED: RESIDENT ENGINEER
DRAWN BY: R. BRADLEY
FILE NO.:
CHECKED BY: D. RICKETTS
SHEET __ OF __ SHEETS

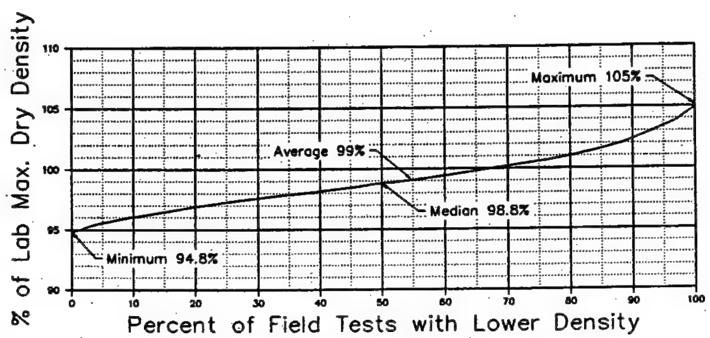
PLATE 26



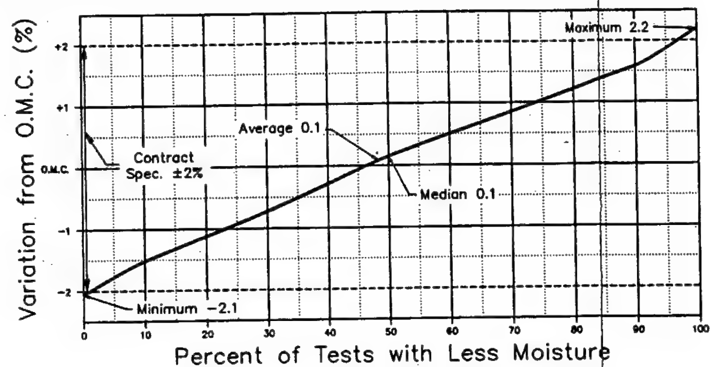
135 Tests from 20 September 1990 through 30 April 1991



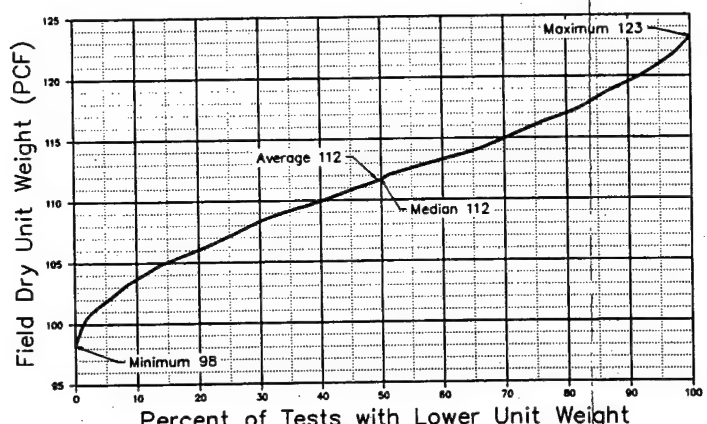
131 Tests from 20 September 1990 through 30 April 1991; 4 Nonplastic



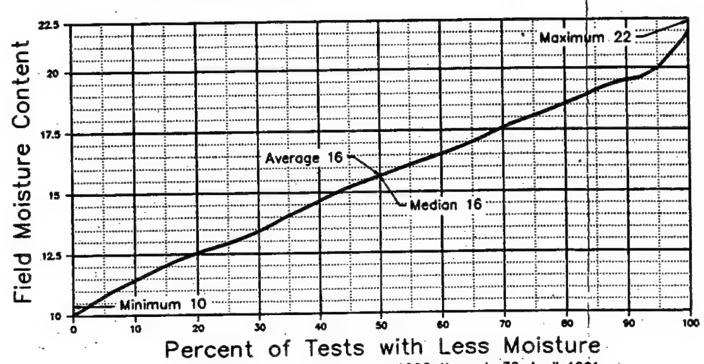
485 Tests from 20 September 1990 through 30 April 1991



485 Tests from 20 September 1990 through 30 April 1991



485 Tests from 20 September 1990 through 30 April 1991



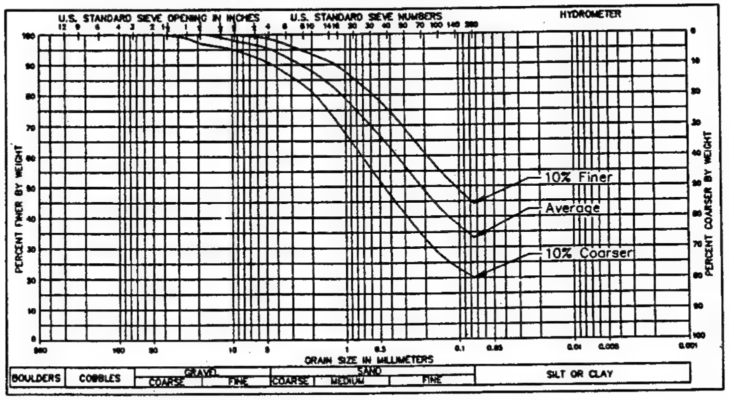
485 Tests from 20 September 1990 through 30 April 1991

FANCHER CREEK DAM
REDBANK AND FANCHER CREEKS FRESNO, CALIFORNIA
SUMMARY OF FIELD TEST RESULTS
EMBANKMENT-CLAY SLOPE PROTECTION

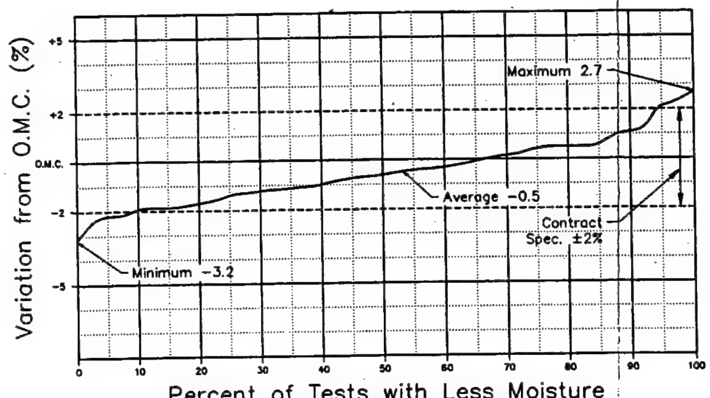
DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SUBMITTED: R. HACKBARTH, EMBANKMENT ENGINEER
SUBMITTED: RESIDENT ENGINEER
DRAWN BY: R. BRADLEY
CHECKED BY: D. RICKETTS
FILE NO.
SHEET ___ OF ___ SHEETS

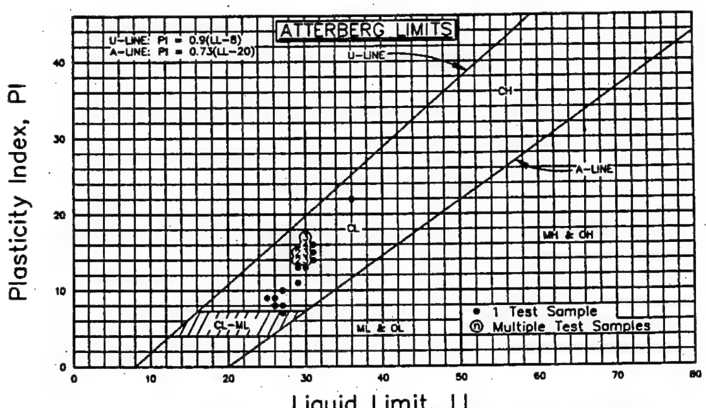
PLATE 27



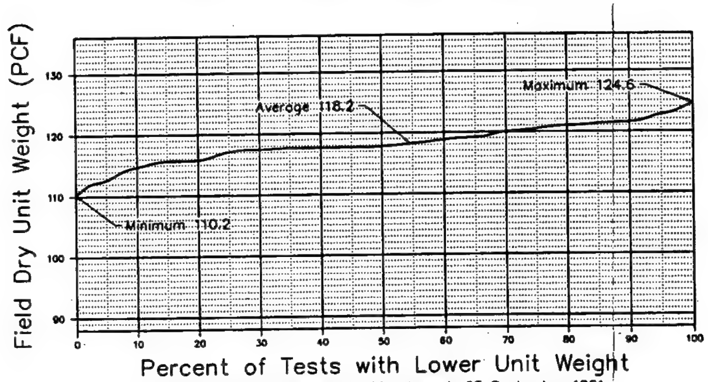
37 Tests from 26 August 1991 through 23 September 1991



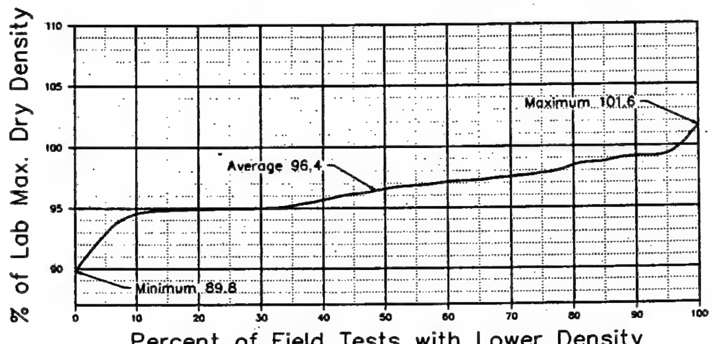
40 Tests from 26 August 1991 through 23 September 1991



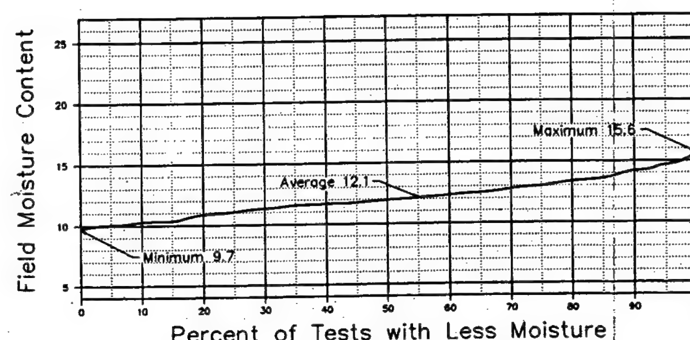
37 Tests from 26 August 1991 through 23 September 1991; 7 Nonplastic



40 Tests from 26 August 1991 through 23 September 1991



40 Tests from 26 August 1991 through 23 September 1991



40 Tests from 26 August 1991 through 23 September 1991

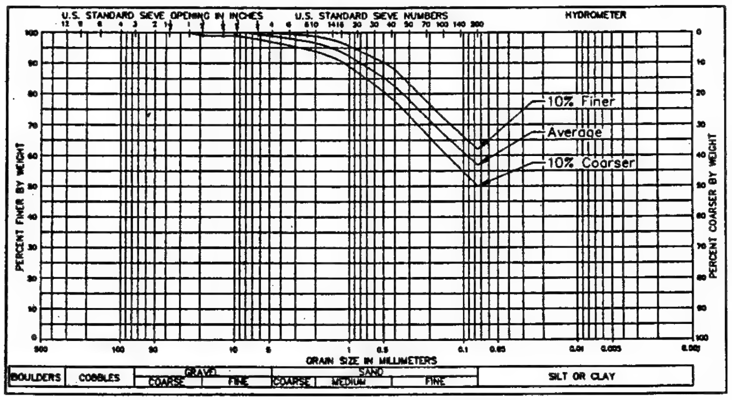
FANCHER CREEK DAM
REDBANK AND FANCHER CREEKS FRESNO, CALIFORNIA

SUMMARY OF FIELD TEST RESULTS
DAM CLOSURE AT OUTLET WORKS
RANDOM FILL AT STRUCTURE

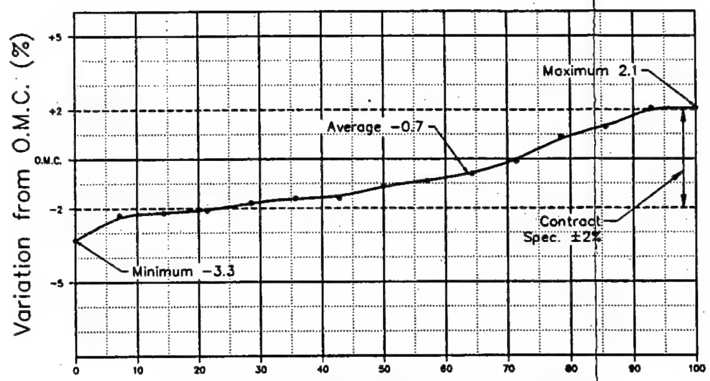
DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SUBMITTED: R. HACKBARTH, ENGINEERING
SUBMITTED: RESIDENT ENGINEER
DRAWN BY: R. BRADLEY
CHECKED BY: D. RICKETTS
FILE NO.: ----
SHEET __ OF __ SHEETS

PLATE 28

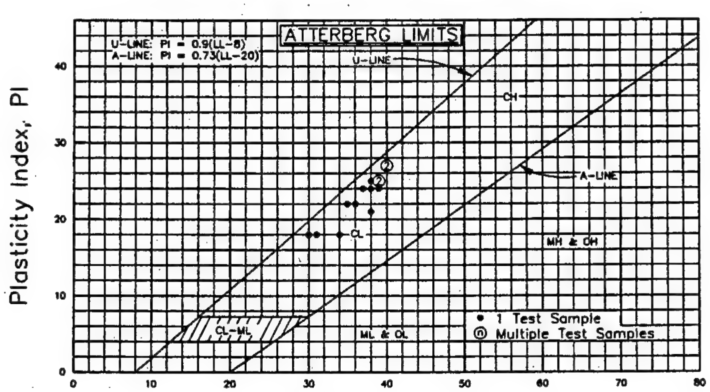


14 Tests from 26 August 1991 through 23 September 1991



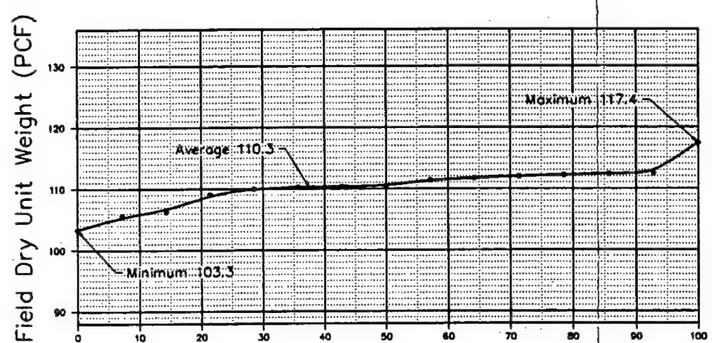
Percent of Tests with Less Moisture

15 Tests from 26 August 1991 through 23 September 1991



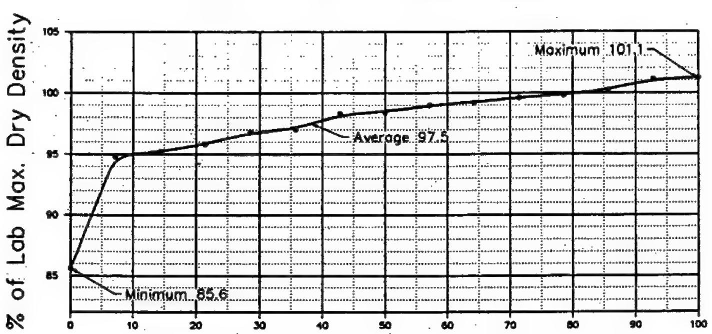
Liquid Limit, LL

14 Tests from 26 August 1991 through 23 September 1991



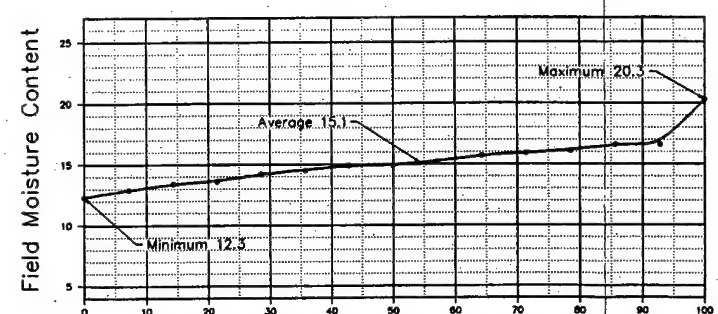
Percent of Tests with Lower Unit Weight

15 Tests from 26 August 1991 through 23 September 1991



Percent of Field Tests with Lower Density

15 Tests from 26 August 1991 through 23 September 1991

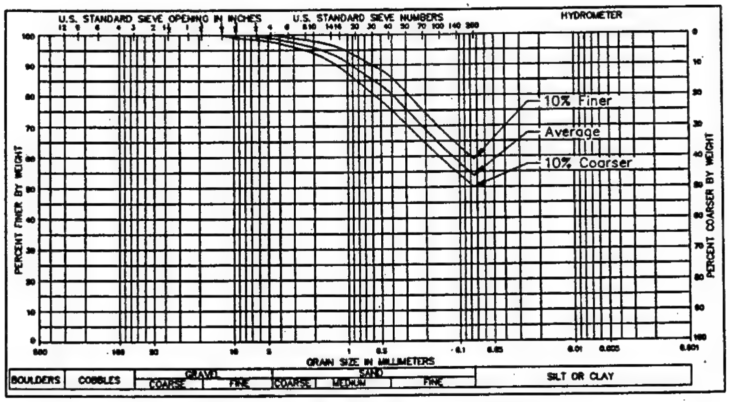


Percent of Tests with Less Moisture

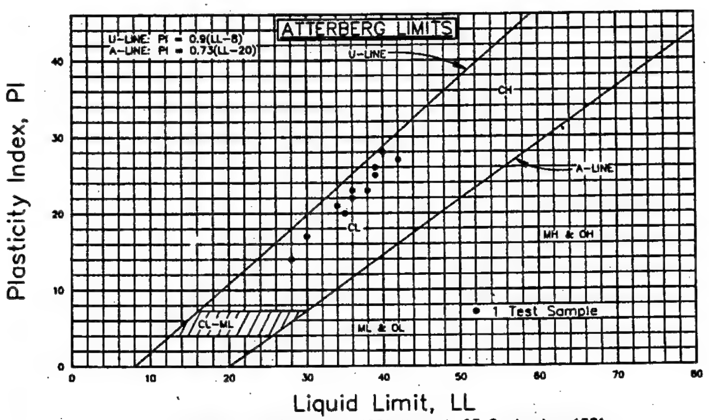
15 Tests from 26 August 1991 through 23 September 1991

FANCHER CREEK DAM REDBANK AND FANCHER CREEKS FRESNO, CALIFORNIA SUMMARY OF FIELD TEST RESULTS DAM CLOSURE AT OUTLET WORKS CLAY SLOPE PROTECTION AT STRUCTURE	
DEPARTMENT OF THE ARMY SACRAMENTO DISTRICT, CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA	
SUBMITTED: R. HACKBARTH, EMBANKMENT ENGINEER	SUBMITTED: [signature] RESIDENT ENGINEER
DRAWN BY: R. BRADLEY	FILE NO.:
CHECKED BY: D. RICKETTS	SHEET __ OF __ SHEETS

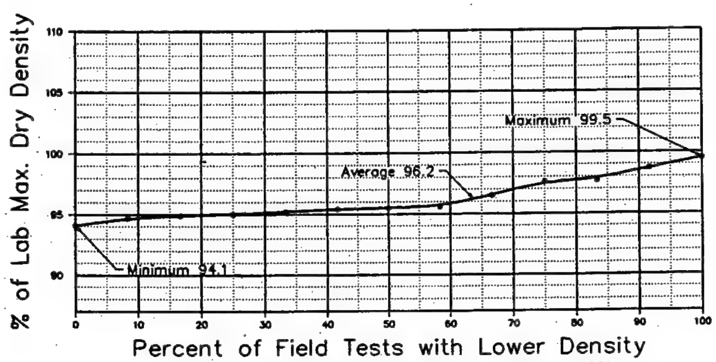
PLATE 29



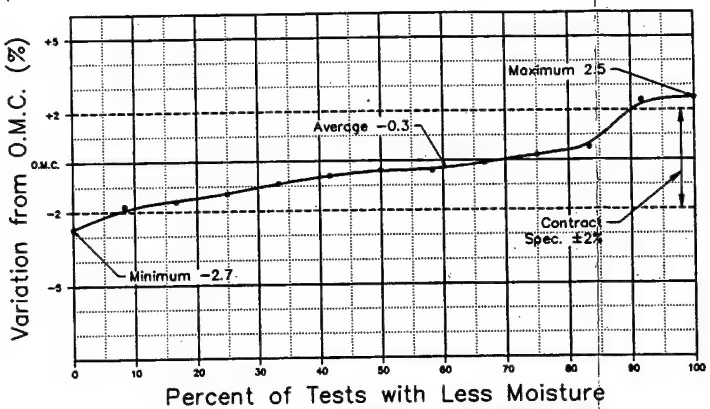
11 Tests from 26 August 1991 through 23 September 1991



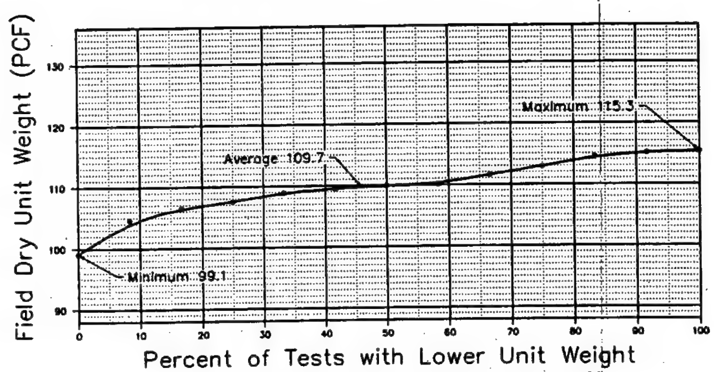
11 Tests from 26 August 1991 through 23 September 1991



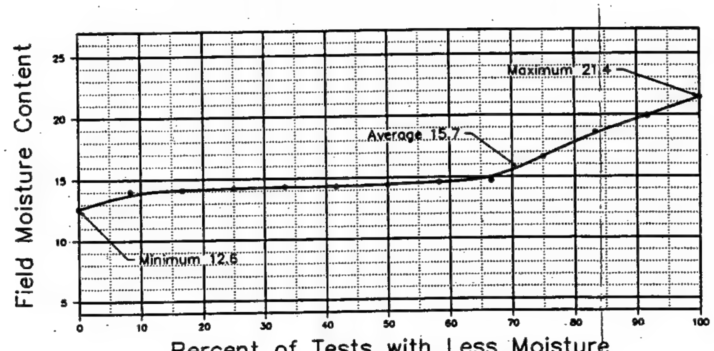
13 Tests from 26 August 1991 through 23 September 1991



13 Tests from 26 August 1991 through 23 September 1991



13 Tests from 26 August 1991 through 23 September 1991



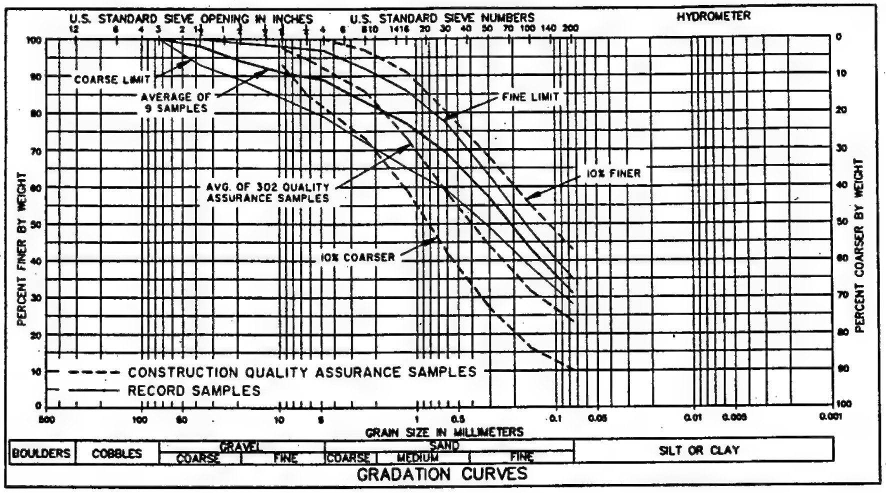
13 Tests from 26 August 1991 through 23 September 1991

FANCHER CREEK DAM
REDBANK AND FANCHER CREEKS FRESNO, CALIFORNIA
SUMMARY OF FIELD TEST RESULTS
DAM CLOSURE AT OUTLET WORKS
CLAY PLUG AT OGEE

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

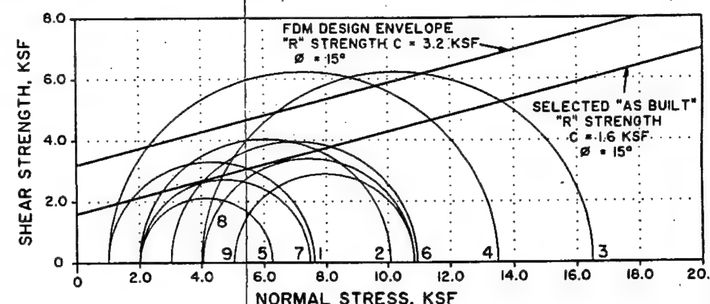
SUBMITTED: R. HACKBARTH
SUBMITTED: RESIDENT ENGINEER
DRAWN BY: R. BRADLEY
CHECKED BY: D. RICKETTS
FILE No.:
SHEET ___ OF ___ SHEETS

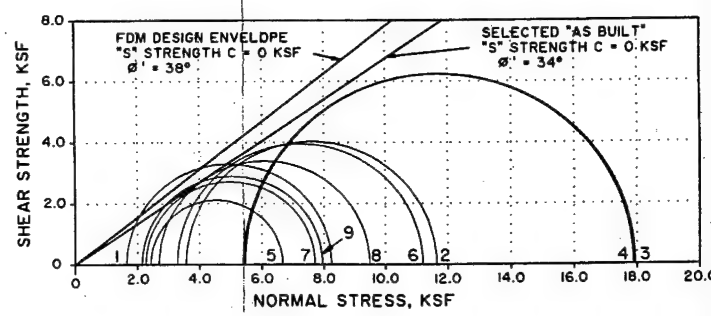
PLATE 30

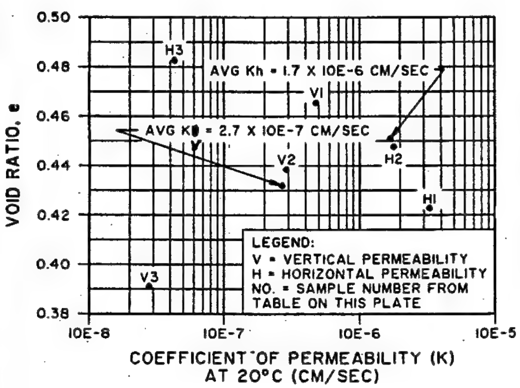


GRADATION CURVES

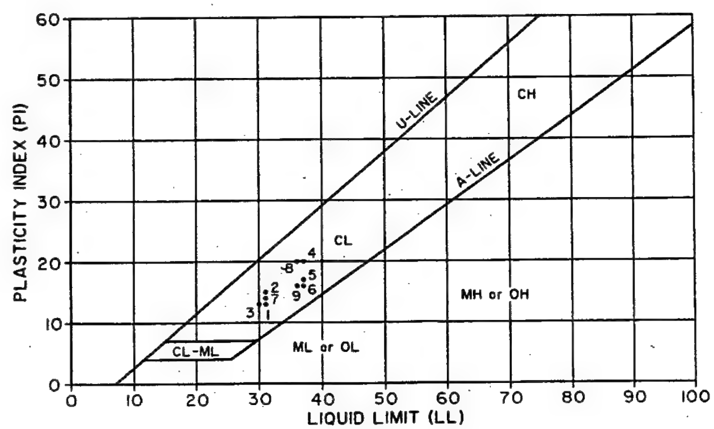
NO.	DIVISION SAMPLE NO.	MATERIAL CLASS. SYMBOL	TYPE OF SAMPLE	PROPERTIES					
				INITIAL			FINAL		
				DRY DENSITY (PCF)	MOISTURE CONTENT (%)	SATURATION (%)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	SATURATION (%)
1	114824	SC	UNDISTURBED	116.6	15.0	86.1	117.7	16.9	100
2	114825	SC	UNDISTURBED	114.8	14.0	76.4	119.5	15.3	95
3	114826	SC	UNDISTURBED	120.0	12.9	81.1	124.3	14.1	100
4	116514	SC	UNDISTURBED	120.6	12.6	89.8	121.1	14.1	100
5	116515	SC	UNDISTURBED	101.7	21.9	92.5	102.7	21.6	100
6	116516	SC	UNDISTURBED	103.0	14.0	61.2	104.5	22.0	100
7	116517	SC	UNDISTURBED	106.7	13.5	63.1	109.0	18.6	100
8	116518	SC	UNDISTURBED	113.1	16.5	91.2	115.5	17.3	100
9	116519	SC	UNDISTURBED	115.9	15.4	91.5	119.8	15.4	100







COEFFICIENT OF PERMEABILITY (K) AT 20°C (CM/SEC)



ATTERBERG LIMITS

FANCHER CREEK DAM
REDBANK AND FANCHER CREEKS — FRESNO, CALIFORNIA
FANCHER CREEK DAM
RANDOM FILL
RECORD TEST RESULTS

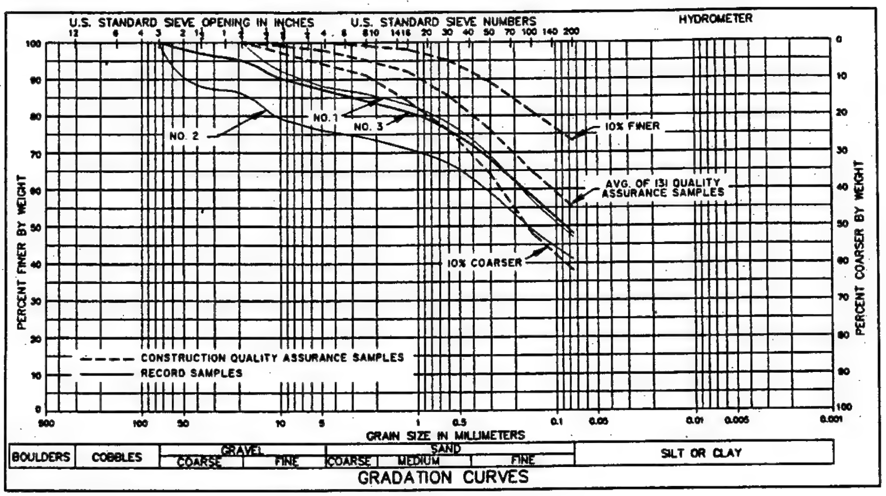
DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SUBMITTED: R. HACKBARTH, EMBANKMENT ENGINEER
DRAWN BY: R. IWASA
CHECKED BY: D. RICKETTS
SUBMITTED: RESIDENT ENGINEER
SHEET ___ OF ___ SHEETS

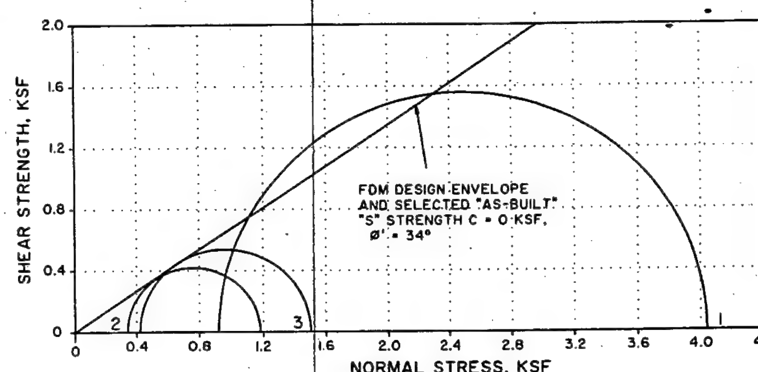
GEO TECH - SOILS\R.IWASA\FAN-RTR1.DWG\05-13-94

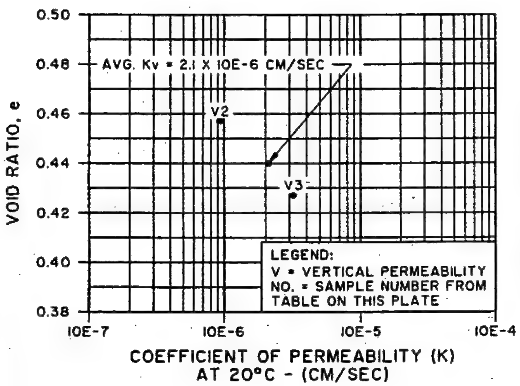
PLATE 31

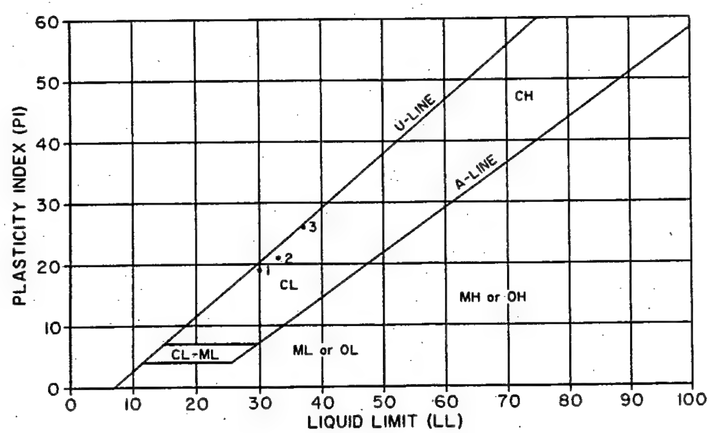
NO.	DIVISION SAMPLE NO.	MATERIAL CLASS. SYMBOL	TYPE OF SAMPLE	PROPERTIES					
				INITIAL			FINAL		
				DRY DENSITY (PCF)	MOISTURE CONTENT (%)	SATURATION (%)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	SATURATION (%)
1	114827	SC	UNDISTURBED	121.9	10.1	71.6	121.8	14.2	100
2	114828	SC	UNDISTURBED	104.9	13.2	58.8	110.7	19.3	100
3	114829	SC	UNDISTURBED	112.3	12.2	66.1	113.4	18.0	100



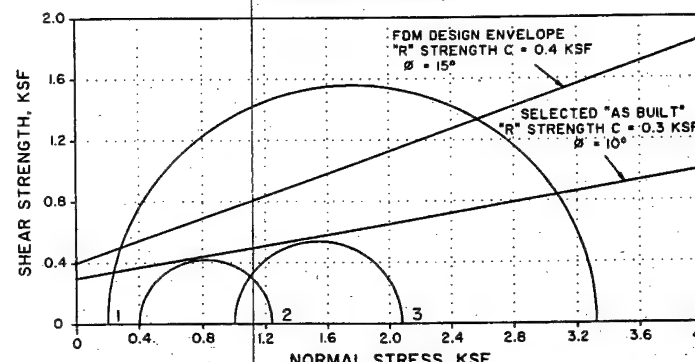
GRADATION CURVES







ATTERBERG LIMITS



FANCHER CREEK DAM
REDBANK AND FANCHER CREEKS FRESNO, CALIFORNIA

FANCHER CREEK DAM
CLAY SLOPE PROTECTION
RECORD TEST RESULTS

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SUBMITTED: R. HACKBARTH

SUBMITTED:

DRAWN BY: R. IWASA

CHECKED BY: D. RICKETTS

SHEET __ OF __ SHEETS

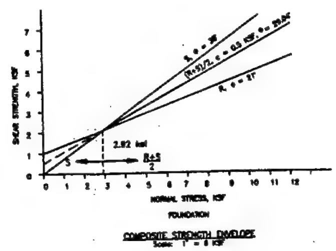
GEO TECH - SOILS\R.IWASA\FAN-RTR2.DWG\05-13-94

PLATE 32

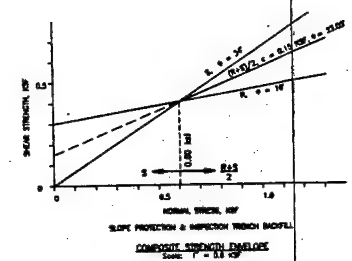
SLICE NO.	SEGMENT NO.	SEGMENT AREA (sq. ft.)	SOIL UNIT WEIGHT (pcf) MOIST	SOIL UNIT WEIGHT (pcf) SUB-MERGED	SLICE WEIGHT (kips)	BASE LENGTH OF SLICE, ΔL (ft.)	ϕ_D * (deg.)
1	1	9.1	130	–	1.2	7.0	18.9
2	2a	54.3	130	–	15.4	18.7	18.9
	2b	60.3	134	–			
3	3a	42.6	130	–	20.33	12.9	18.9
	3b	110.4	134	–			
4	4a	46.1	130	–	26.28	12.9	18.9
	4b	151.4	134	–			
5	5a	54.1	130	–	30.56	14.3	18.9
	5b	154.8	134	–			
	5c	36.8	–	75.6			
6	6a	45.2	130	–	21.66	11.5	12.2 (R+S)/2
	6b	77.0	134	–			
	6c	59.8	–	75.6			
	6d	13.4	–	70.6			
7	7a	45.6	130	–	17.02	11.4	12.2 (R+S)/2
	7b	29.7	134	–			
	7c	65.3	–	75.6			
	7d	30.7	–	70.6			
8	8a	23.3	130	–	10.83	11.4	12.2 (R+S)/2
	8b	0.3	134	–			
	8c	22.4	–	70.6			
	8d	51.5	–	75.6			
	8e	32.5	–	70.6			
9	9a	61.9	–	70.6	5.15	11.4	18.9
	9b	10.4	–	75.6			
10	10a	4.6	–	70.6	1.04	9.7	20.2
	10b	9.6	–	74.6			

* FOR F.S. = 1.97

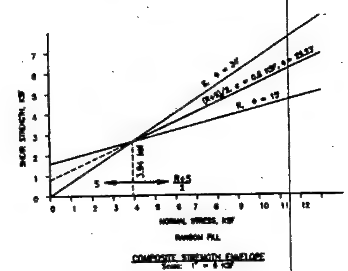
$\phi_D = \tan^{-1} \cdot \frac{\tan \phi}{F.S.}$



COMPOSITE STRENGTH ENVELOPE
Scale: 1" = 6 KSF

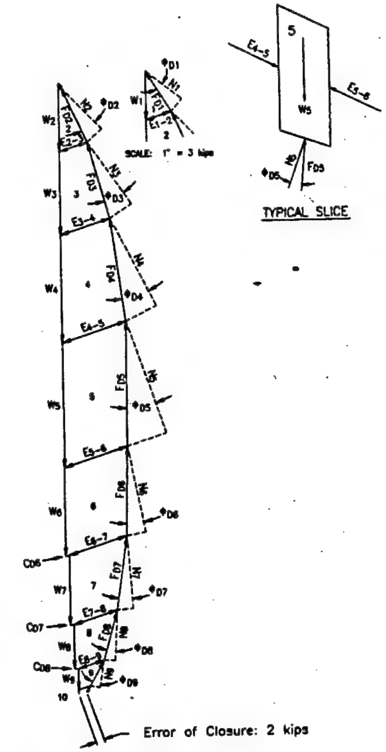


COMPOSITE STRENGTH ENVELOPE
Scale: 1" = 0.8 KSF

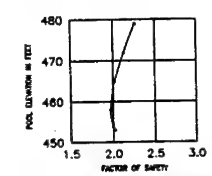


COMPOSITE STRENGTH ENVELOPE
Scale: 1" = 6 KSF

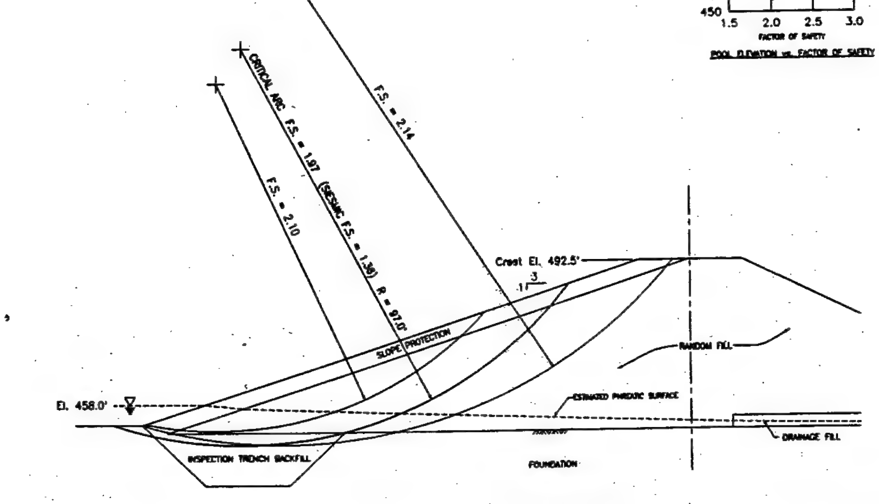
SELECTED DESIGN DATA								
MATERIAL	UNIT WEIGHT (pcf)		S-STRENGTH		R-STRENGTH		(R+S) / 2	
	γ_m–Moist	γ_s–Saturated	φ (deg.)	COHESION, c (kips/sq. ft.)	φ (deg.)	COHESION, c (kips/sq. ft.)	φ (deg.)	COHESION (kips/sq. ft.)
RANDOM FILL	134	138	34	0	15	1.6	25.2	0.8
SLOPE PROTECTION	130	133	34	0	10	0.3	23	0.15
DRAINAGE FILL	125	130	36	0	36	0	36	0
FOUNDATION	–	137	36	0	21	1.0	29	0.5



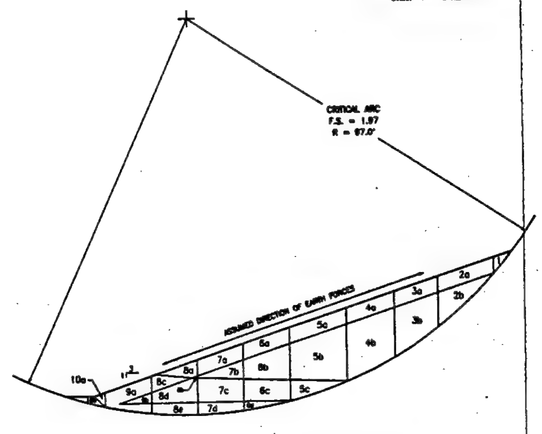
COMPOSITE FORCE POLYGON FOR TRIAL F.S. = 1.97
SCALE: 1" = 30 kips



POOL ELEVATION vs. FACTOR OF SAFETY



EMBANKMENT SECTION
Scale: 1" = 30'



SELECTED FAILURE ARC
Scale: 1" = 30'

GRAPHIC SCALES
SCALE: 1" = 30 FEET
SCALE: 1" = 30 kips

NOTES

1. Steady Seepage analysis for finite slice method performed by the UTEXAS3 program.
2. The computer solution for the Selected Failure Arc shown was a Factor of Safety of 1.97 . The manual check of this solution agreed closely.
3. The seismic condition assumes a horizontal force of 0.10 times the slice weight.

FANCHER CREEK DAM
REDBANK AND FANCHER CREEKS — FRESNO, CALIFORNIA
AS-CONSTRUCTED
STABILITY ANALYSIS RESULTS
PARTIAL POOL CONDITION

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SUBMITTED: R. HACKBARTH, EMBANKMENT ENGINEER
DRAWN BY: R. BRADLEY
CHECKED BY: D. RICKETTS
SUBMITTED: RESIDENT ENGINEER

PLATE 33

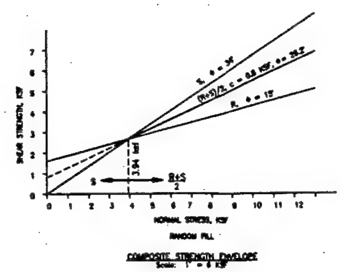
MATERIAL	UNIT WEIGHT (pcf)		S-STRENGTH		R-STRENGTH		(R+S) / 2	
	γ_m-Moist	γ_s-Saturated	φ (deg.)	COHESION, c (kips/sq. ft.)	φ (deg.)	COHESION, c (kips/sq. ft.)	φ (deg.)	COHESION (kips/sq. ft.)
RANDOM FILL	134	138	34	0	15	1.6	25.2	0.8
SLOPE PROTECTION	130	133	34	0	10	0.3	23	0.15
DRAINAGE FILL	125	130	36	0	36	0	36	0
FOUNDATION	-	137	36	0	21	1.0	29	0.5

SELECTED DESIGN DATA

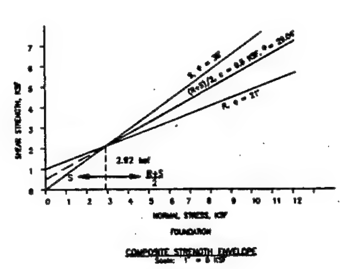
SLICE NO.	SEGMENT NO.	SEGMENT AREA (sq. ft.)	SOIL UNIT WEIGHT (pcf) MOIST	SOIL UNIT WEIGHT (pcf) SUB-MERGED	SEGMENT WEIGHT (kips)	SLICE WEIGHT (kips)	BASE LENGTH OF SLICE, ΔL (ft.)	ϕ_D* (deg.)
1	1	31.2	134	-	4.18	4.18	13.1	24.1
2	2	69.0	134	-	9.25	9.25	11.7	24.1
3	3	91.6	134	-	12.27	12.27	10.8	24.1
4	4	102.7	134	-	13.77	13.77	10.2	24.1
5	5	104.4	134	-	13.99	13.99	9.7	24.1
6	6	97.8	134	-	13.10	13.10	9.4	24.1
7	7	83.7	134	-	11.22	11.22	9.2	24.1
8	8a	53.3	134	-	7.15	8.06	8.6	25.7
	8b	7.3	125		0.91			
9	9a	17.8	134	-	2.38	4.65	8.5	25.7
	9b	18.1	125		2.27			
10	10	7.5	125	-	0.94	0.94	5.7	25.7

$\phi_D = \tan^{-1} \frac{\tan\phi}{F.S.}$

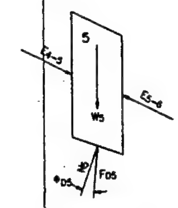
*FOR F.S. = 1.51



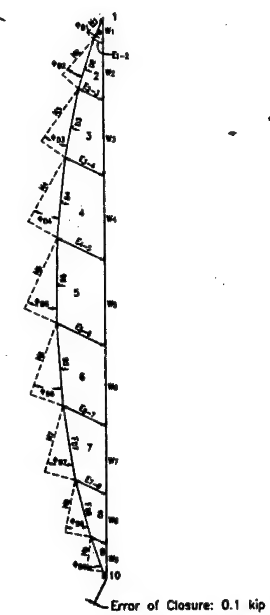
COMPOSITE STRENGTH ENVELOPE
Scale: 1" = 6 KSF



COMPOSITE STRENGTH ENVELOPE
Scale: 1" = 6 KSF

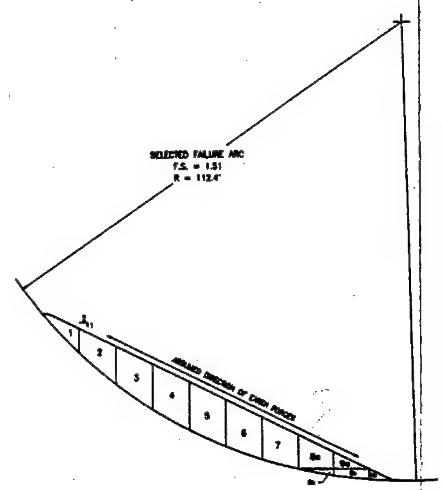


TYPICAL SLICE

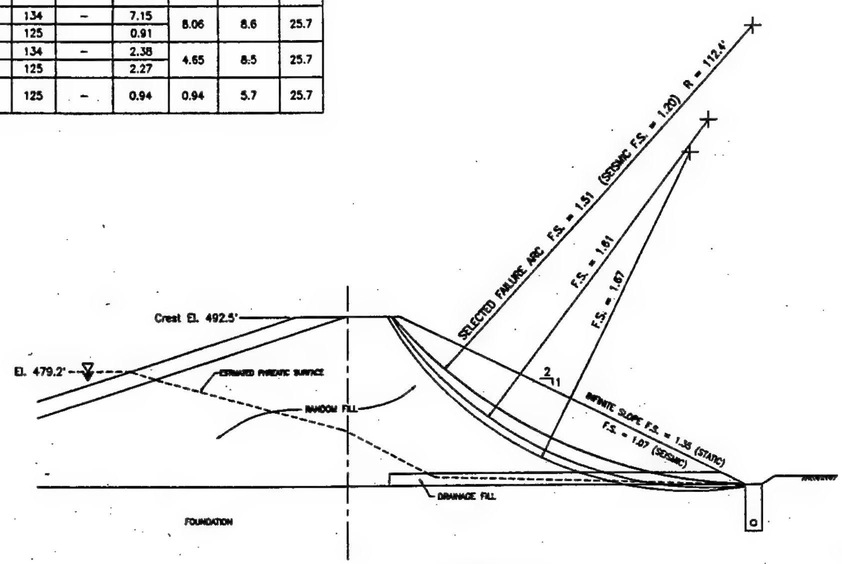


COMPOSITE FORCE POLYGON FOR TRIAL F.S. = 1.51

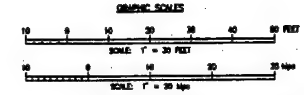
SCALE: 1" = 20 kips



SELECTED FAILURE ARC
Scale: 1" = 30'



EMBANKMENT SECTION
Scale: 1" = 30'



NOTES

1. Steady Seepage analysis for finite slice method performed by the UTEXAS3 program. Failure arcs shown are considered representative of the more significant portions of the embankment. Factors of Safety decrease to the infinite slope condition for both static and seismic conditions.
2. The computer solution for the Selected Failure Arc shown is a Factor of Safety of 1.51. The manual check of this solution agrees closely.
3. The seismic condition assumes a horizontal force of 0.10 times the slice weight.

FANCHER CREEK DAM
REDBANK AND FANCHER CREEKS FRESNO, CALIFORNIA
AS-CONSTRUCTED
STABILITY ANALYSIS RESULTS
STEADY SEEPAGE CONDITION

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SUBMITTED: R. HACKBARTH, EMBANKMENT ENGINEER
DRAWN BY: R. BRADLEY
CHECKED BY: D. RICKETTS
SUBMITTED: RESIDENT ENGINEER

SHEET ___ OF ___ SHEETS

PLATE 34

SLICE NO.	SEGMENT NO.	SEGMENT AREA (sq. ft.)	SOIL UNIT WEIGHT (pcf) MOIST	SOIL UNIT WEIGHT (pcf) SATURATED	SOIL UNIT WEIGHT (pcf) SUBMERGED	SEGMENT WEIGHT (kips) MOIST	SEGMENT WEIGHT (kips) SATURATED	SEGMENT WEIGHT (kips) SUBMERGED	SLICE WEIGHT (kips) Before Drawdown	SLICE WEIGHT (kips) After Drawdown	BASE LENGTH OF SLICE ΔL (ft.)	ϕ_B (deg.)
1	1	7.40	130	-	-	0.96	-	-	0.96	0.96	6.29	18.0
2	2a	17.33	130	-	-	2.25	-	-	4.88	7.06	11.14	18.0
	2b	12.00	-	133	70.6	-	1.60	0.85				
	2c	0.33	134	-	-	0.04	-	-				
	2d	22.96	-	138	75.6	-	3.17	1.74				
3	3a	27.07	-	133	70.6	-	3.60	1.91	5.94	10.95	8.98	18.0
	3b	53.25	-	138	75.6	-	7.35	4.03				
4	4a	29.72	-	133	70.6	-	3.95	2.10	8.25	15.18	8.98	18.0
	4b	81.35	-	138	75.6	-	11.23	6.15				
5	5a	31.93	-	133	70.6	-	4.25	2.25	10.06	18.42	8.98	18.0
	5b	102.10	-	138	75.6	-	14.09	7.72				
	5c	1.16	-		75.6	-	-	0.09				
6	6a	33.67	-	133	70.6	-	4.48	2.38	11.16	18.96	8.98	18.0
	6b	91.35	-	138	75.6	-	12.61	6.91				
	6c	24.79	-	-	75.6	-	-	1.87				
7	7a	31.48	-	133	70.6	-	4.19	2.22	10.26	16.02	7.57	4.9
	7b	60.75	-	138	75.6	-	8.38	4.59				
	7c	39.08	-	-	75.6	-	-	2.95				
	7d	6.95	-	-	70.6	-	-	0.49				
8	8a	32.13	-	133	70.6	-	4.27	2.27	9.70	14.04	8.10	4.9
	8b	37.42	-	138	75.6	-	5.16	2.83				
	8c	43.20	-	-	75.6	-	-	3.27				
	8d	18.88	-	-	70.6	-	-	1.33				
9	9a	32.39	-	133	70.6	-	4.31	2.29	8.47	11.28	8.10	4.9
	9b	12.61	-	138	75.6	-	1.74	0.95				
	9c	46.90	-	-	75.6	-	-	3.55				
	9d	23.88	-	-	70.6	-	-	1.69				
10	10a	18.00	-	133	70.6	-	2.39	1.27	7.26	8.39	9.05	4.9
	10b	18.00	-	-	70.6	-	-	1.27				
	10c	40.50	-	-	75.6	-	-	3.06				
	10d	23.52	-	-	70.6	-	-	1.66				
11	11a	37.13	-	-	70.6	-	-	2.62	4.39	4.39	9.52	4.9
	11b	13.50	-	-	75.6	-	-	1.02				
	11c	10.66	-	-	70.6	-	-	0.75				
12	12	11.60	-	-	70.6	-	-	0.82	0.82	0.82	6.07	18.0

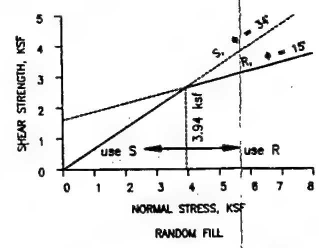
Computation of Factor of Safety – Sudden Drawdown

$$F.S. = \frac{\Sigma (N_D \tan\phi + c\,\Delta L)}{\Sigma W \sin\theta}$$

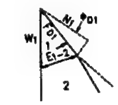
Where: N_D = Normal Effective Force Before Drawdown
W = Slice Weight After Drawdown

Slice	N_D (kips)	$\tan\phi$	$N_D \tan\phi$	Base Length ΔL (ft.)	c ΔL (kips)	W (kips)	θ (deg.)	sin θ	W sin θ (kips)
1	0.92	0.675	0.62	6.3	0	0.96	55.5	0.824	0.79
2	4.51	0.675	3.04	11.1	0	7.06	48.8	0.752	5.31
3	5.37	0.675	3.62	9.0	0	10.95	41.0	0.656	7.19
4	7.45	0.675	5.02	9.0	0	15.18	34.1	0.561	8.51
5	9.20	0.675	6.20	9.0	0	18.42	27.2	0.456	8.41
6	10.48	0.675	7.07	9.0	0	18.96	20.2	0.346	6.56
7	9.93	0.176	1.75	7.6	2.27	16.02	13.6	0.236	3.78
8	9.76	0.176	1.72	8.1	2.43	14.04	7.4	0.128	1.81
9	9.02	0.176	1.59	8.1	2.43	11.28	1.1	0.020	0.22
10	8.44	0.176	1.49	9.0	2.71	8.39	-5.5	-0.096	-0.80
11	6.01	0.176	1.06	9.5	2.86	4.39	-12.7	-0.219	-0.96
12	1.31	0.675	0.89	6.1	0	0.82	-19.3	-0.330	-0.27
		Total:	34.08	Total:	12.70			Total:	40.53

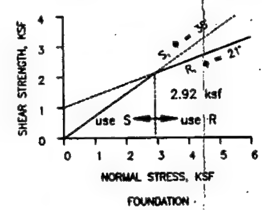
$$F.S. = \frac{46.78}{40.53} = 1.15$$



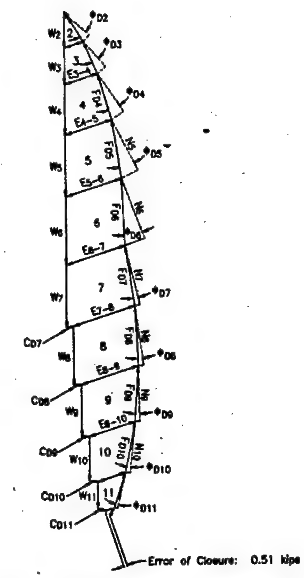
COMPOSITE STRENGTH ENVELOPE
Scale: 1" = 4 KSF



SCALE: 1" = 2 kips

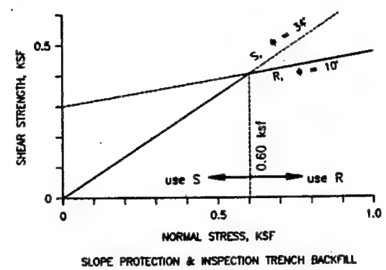


COMPOSITE STRENGTH ENVELOPE
Scale: 1" = 4 KSF

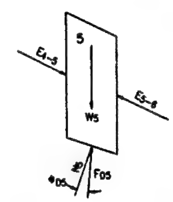


COMPOSITE FORCE POLYGON FOR TRIAL F.S. = 2.07
SCALE: 1" = 20 kips

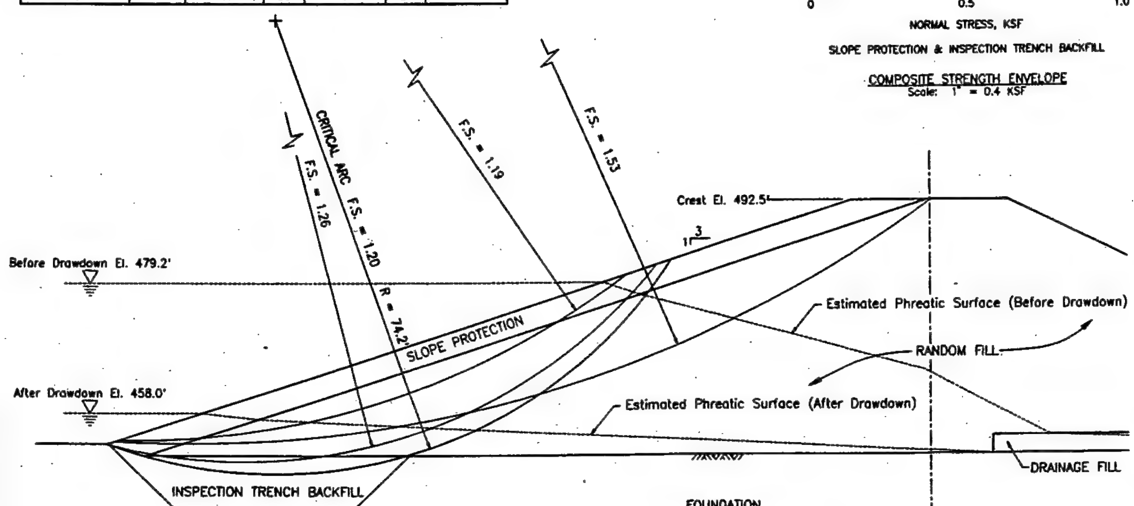
SELECTED AS-CONSTRUCTED DATA						
MATERIAL	UNIT WEIGHT (pcf)		S-STRENGTH		R-STRENGTH	
	γ_m-Moist	γ_s-Saturated	φ (deg.)	COHESION, c (kips/sq. ft.)	φ (deg.)	COHESION, c (kips/sq. ft.)
RANDOM FILL	134	138	34	0	15	1.8
SLOPE PROTECTION	130	133	34	0	10	0.3
DRAINAGE FILL	125	130	38	0	36	0
FOUNDATION	-	137	36	0	21	1.0



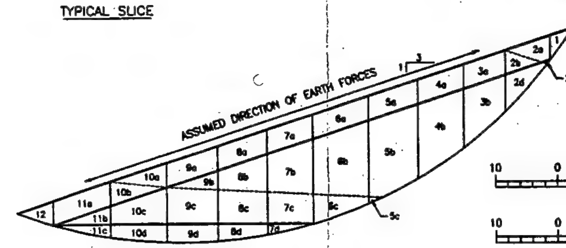
COMPOSITE STRENGTH ENVELOPE
Scale: 1" = 0.4 KSF



TYPICAL SLICE

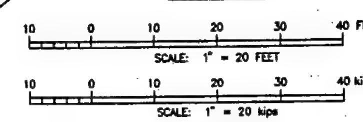


EMBANKMENT SECTION
Scale: 1" = 20'



SELECTED FAILURE ARC
Scale: 1" = 20'

GRAPHIC SCALES



NOTES:

1. The Sudden Drawdown analysis was performed using the Modified Swedish Method.
2. The computer solution for the Selected Failure Arc shown was a Factor of Safety of 1.20. The manual check of this solution agreed closely.

FANCHER CREEK DAM
REDBANK AND FANCHER CREEKS FRESNO, CALIFORNIA
AS-CONSTRUCTED
STABILITY ANALYSIS RESULTS
SUDDEN DRAWDOWN CONDITION

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SUBMITTED: R. HACKBARTH, EMBANKMENT ENGINEER
SUBMITTED: RESIDENT ENGINEER
DRAWN BY: R. BRADLEY
CHECKED BY: D. RICKETTS
SHEET ___ OF ___ SHEETS

APPENDIX A

DEPARTMENT OF THE ARMY
SOUTH PACIFIC DIVISION, CORPS OF ENGINEERS
LABORATORY
25 LIBERTY SHIP WAY, SAUSALITO, CALIFORNIA 94965-1768

REPLY TO
ATTENTION OF:

CESPD-ED-GL (1110-1-8100b) 27 MAR 1991

MEMORANDUM FOR Commander, Sacramento District, ATTN: CESPK-ED-GS,
Mr. Casey Jones

SUBJECT: FANCHER CREEK DAM

1. The results of laboratory testing on the subject project (10 plates) are enclosed. Testing consisted of Sieve Analysis, Atterberg Limits, Triaxial Compression, and Flexible-Wall Triaxial Permeability.

2. Test Procedures. Testing generally conformed to the procedures described in Engineer Manual (EM) 1110-2-1906, Laboratory Soils Testing, 30 November 1970 with Change 2 dated 20 August 1986.

3. Soil Classification. Soils, for which laboratory determinations of particle-size characteristics, liquid limit, and plasticity index were conducted, have been classified according to ASTM Standard D 2487, "Classification of Soils for Engineering Purposes."

4. Significant Findings. None.

5. Total cost of testing is $10,500. Billing will be made by the Sacramento District Finance and Accounting Branch.

6. Reference DA Form 2544, No. ED-GS-91-07, dated 13 Dec 90.

FOR THE COMMANDER:

Dennis Thiet for

Encls

J. Z. BEDFORD
Director, SPD Laboratory

INTRA ARMY ORDER FOR REIMBURSABLE SERVICES For use of this form, see AR 37-108 and AR 37-110; the proponent agency is USAFAC.	1. RECEIVING OFFICE CONTROL NUMBER ☐ FUNDED ☐ AUTOMATIC	2. ORDER a. NUMBER: ED-GS-91-07 b. DATE: 13 Dec 90 3. CHANGE ORDER a. NUMBER b. DATE

4. TO BE PERFORMED BY *(Command, Installation or Activity)*, ADDRESS *(Include ZIP Code)*, AND AUTOVON NUMBER	5. ORDERED BY *(Command, Installation or Activity)*, ADDRESS *(Include ZIP Code)*, AND AUTOVON NUMBER
US ARMY ENGINEER DIVISION LABORATORY SOUTH PACIFIC DIVISION P.O. BOX 37 SAUSALITO, CA. 94966	US ARMY ENGINEER DISTRICT, SACRAMENTO CORPS OF ENGINEERS 650 CAPITOL MALL SACRAMENTO, CA 95814-4794

6. DESCRIPTION OF SERVICES TO BE PERFORMED

Fancher Creek Dam

1. This work order request provides funding for testing required on six record samples collected from Fancher Creek Dam. Three 10-inch diameter tubes (one 12-inch long and two 9-inch long) (sta. 59+30, elevation 467.78) were taken from the clay zone and three 10-inch diameter by 18-inches long (sta. 30+00, elevation 481.91) samples were taken from the random zone. These samples will be delivered on or about 14 Dec 90.

1. Perform the following tests.

Clay Sample No.

1. Consolidated-Undrained Shear Test w/pore pressure readings ($\overline{R}$), 2.8-inch dia. with $\sigma_3 = 0.10$ tsf, MA, and AL.
2. Same as above with $\sigma_3 = 0.25$ tsf.
3. Same as above with $\sigma_3 = 0.50$ tsf plus permeability tests with $\sigma_3 = 0.10$ and 0.25 tsf.

Random Sample No.

1. Consolidated-Undrained shear test w/pore pressure readings ($\overline{R}$), 6-inch dia. with $\sigma_3 = 0.5$ tsf, MA, and AL.
2. Same as above with $\sigma_3 = 1.0$ tsf.
3. Same as above with $\sigma_3 = 2.0$ tsf. plus permeability tests with $\sigma_3 = 0.5$, 1.0, and 2.0 tsf.

3. Tests result should be sent to CESPK-ED-GS, ATTN: Casey Jones, by 15 February 1991. The final report should be submitted NLT 28 February 1991.

cc: F&A Br
Prog Mgmt Off
Civil Proj Sec B (Weeks)
Geotech Br.
Soil Des Sec (Jones, Townsend)

7a. NAME AND TITLE OF ORDERING OFFICER	b. SIGNATURE	c. DATE
LEWIS A. WHITNEY Chief, Engineering Division		

ORIGINATING FINANCE AND ACCOUNTING OFFICE APPROVAL

8a. ACCOUNTING CLASSIFICATION	b. AMOUNT
96X4902 RF S96042 (BE1853151B29001)(GS)	$6,500.00

c. CHANGE

INCREASE AMOUNT ________ DECREASE AMOUNT ________ REVISED AMOUNT ________

9. Services to be performed pursuant to this order are properly chargeable to the appropriations or other accounts indicated above until 31 Mar 91 *(Day - Month - Year)*, the expiration date of this order.

10a. TYPED NAME AND TITLE OF APPROVING OFFICER	b. SIGNATURE	c. DATE
BETTY A. PUGNER Finance and Accounting Officer		

ACCEPTING OFFICER

THE ABOVE TERMS AND CONDITIONS ARE SATISFACTORY AND ARE ACCEPTED.

11a. TYPED NAME AND TITLE OF ACCEPTING OFFICER	b. SIGNATURE	c. DATE ACCEPTED

U.S. ARMY CORPS OF ENGINEERS, SOUTH PACIFIC DIVISION LABORATORY, SAUSALITO, CALIFORNIA

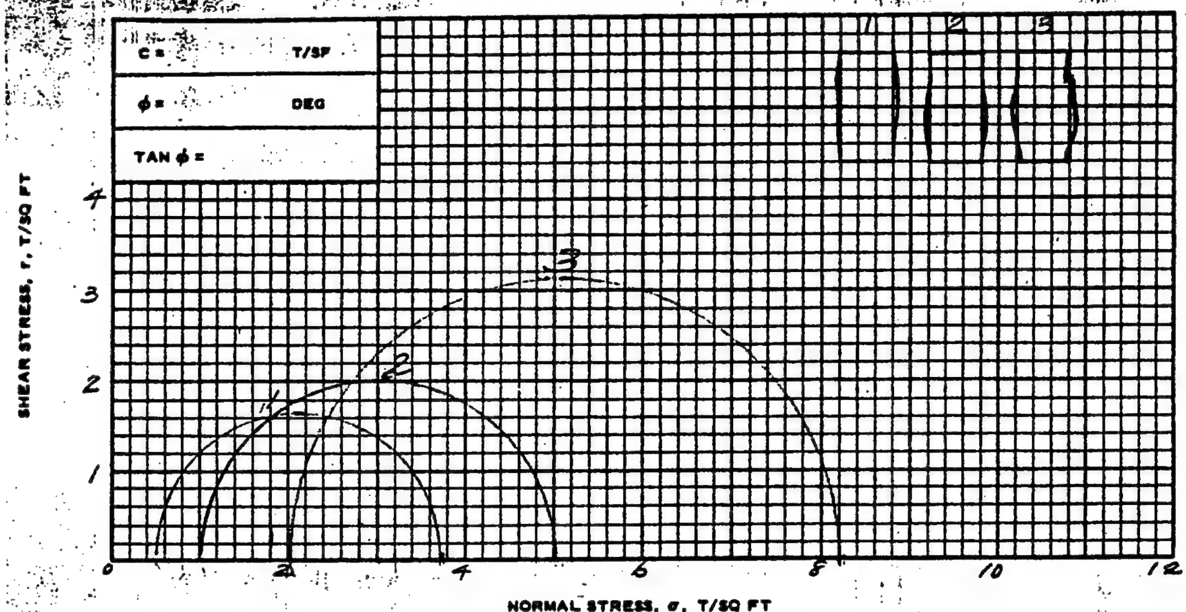
SOIL TEST RESULT SUMMARY

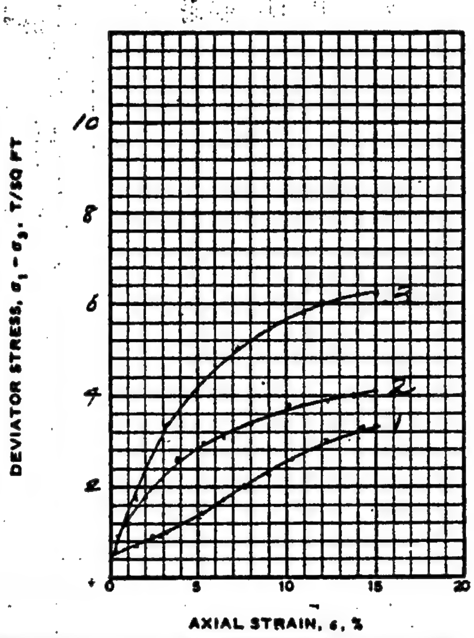
PROJECT: FANCHER CREEK DAM

DATE: March 1991

Division Number	Hole Number	Field Sample No.	Depth or Elevation From	To	Laboratory Descriptive Classification	GRAVEL 12	6	3	1.5	3/4	PERCENT FINER 3/8	#4	SAND #8	#16	#30	#50	#100	FINE #200	Liquid Limit	Plasticity Index	GS +4 -4	Chunk Density Lb/cu ft	Moisture Content %
114824	30 + 00	1	481.9	481.9	Clayey sand (SC)	100	100	100	100	99	98	97	91	82	71	57	41	30	31	13			15.0
114825	30 + 00	2	481.9	481.9	Clayey sand (SC)	100	100	100	100	97	94	93	91	86	77	63	45	32	31	15			14.0
114826	30 + 00	3	481.9	481.9	Clayey sand (SC)	100	100	100	100	97	97	96	92	85	75	59	41	28	30	13			12.9
114827	59 + 30	1	467.8	467.8	Clayey sand (SC)	100	100	100	100	100	92	88	86	83	78	69	57	47	30	19			9.1
114828	59 + 30	2	467.8	467.8	Clayey sand with gravel (SC)	100	100	100	88	86	79	76	74	71	67	59	49	41	33	21			11.3
114829	59 + 30	3	467.8	467.8	Clayey sand (SC)	100	100	100	97	95	90	87	84	81	76	68	58	48	37	26			11.4

SPD FORM 66A





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	15.0	14.0	12.9
	DRY DENSITY LB/CU FT	γd_o	116.6	114.8	120.0
	SATURATION, %	S_o	86.1	76.4	81.1
	VOID RATIO	e_o	0.482	0.505	0.441
BEFORE SHEAR	WATER CONTENT, %	w_c	16.9	15.3	14.1
	DRY DENSITY LB/CU FT	γd_c	117.7	119.5	124.3
	SATURATION, %	S_c	100.0	94.9	100.0
	VOID RATIO	e_c	0.468	0.447	0.391
	FINAL BACK PRESSURE, T/SQ FT	u_o	6.5	6.5	6.5
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	3.31	4.04	6.24
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	312	332	474
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	—	—	—
INITIAL DIAMETER, IN.		D_o	6.21	6.30	6.25
INITIAL HEIGHT, IN.		H_o	13.02	13.08	13.68

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS

LL | PL | PI | Gs 2.77 | TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST $\bar{R}$

REMARKS:

1:114824/F.S. 1
2:114825/F.S-2
3:114826/F.S-3

PROJECT FANCHER CREEK DAM
RANDOM FILL

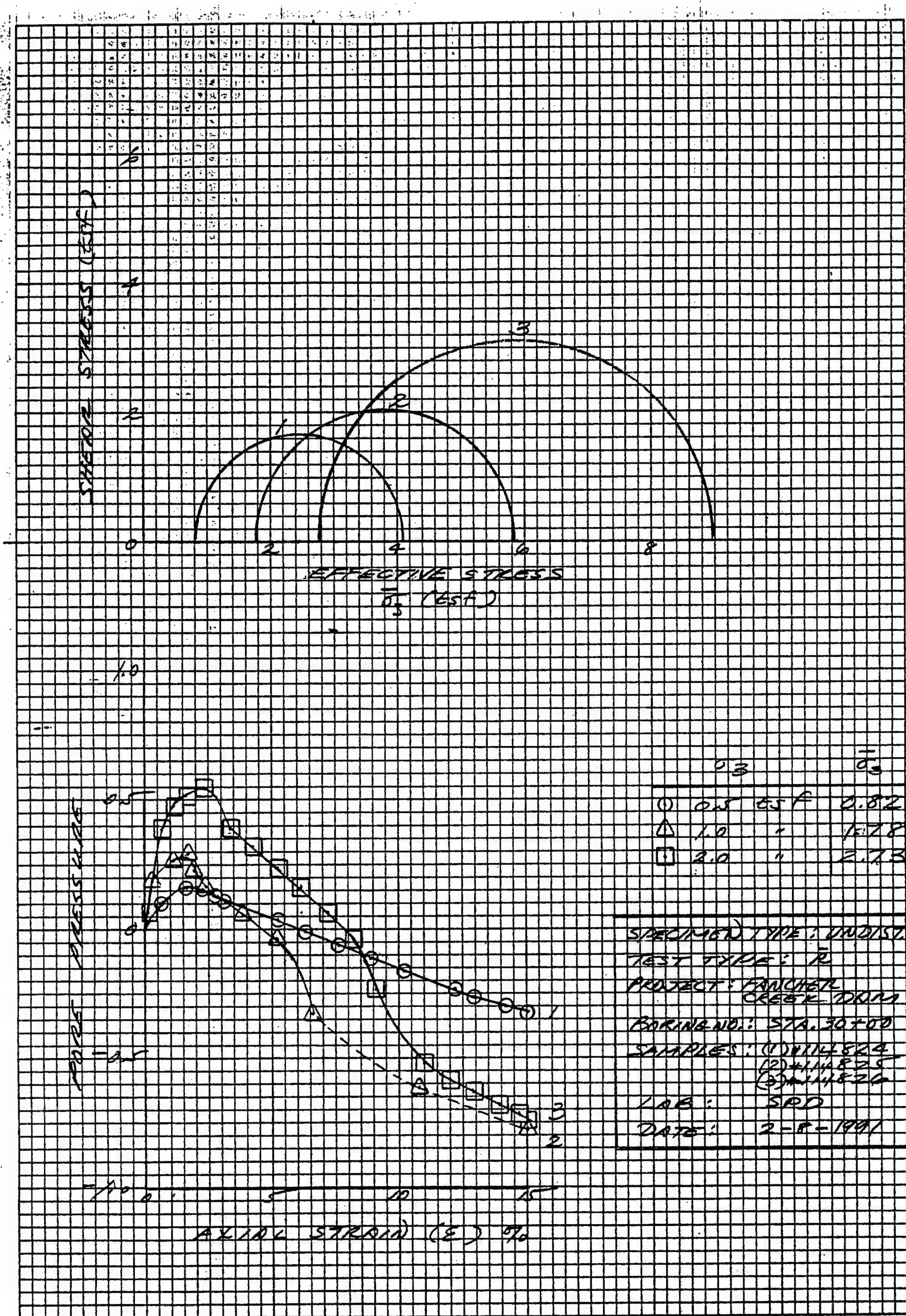
BORING NO. STA. 30+00 | SAMPLE NO. 114824-114826

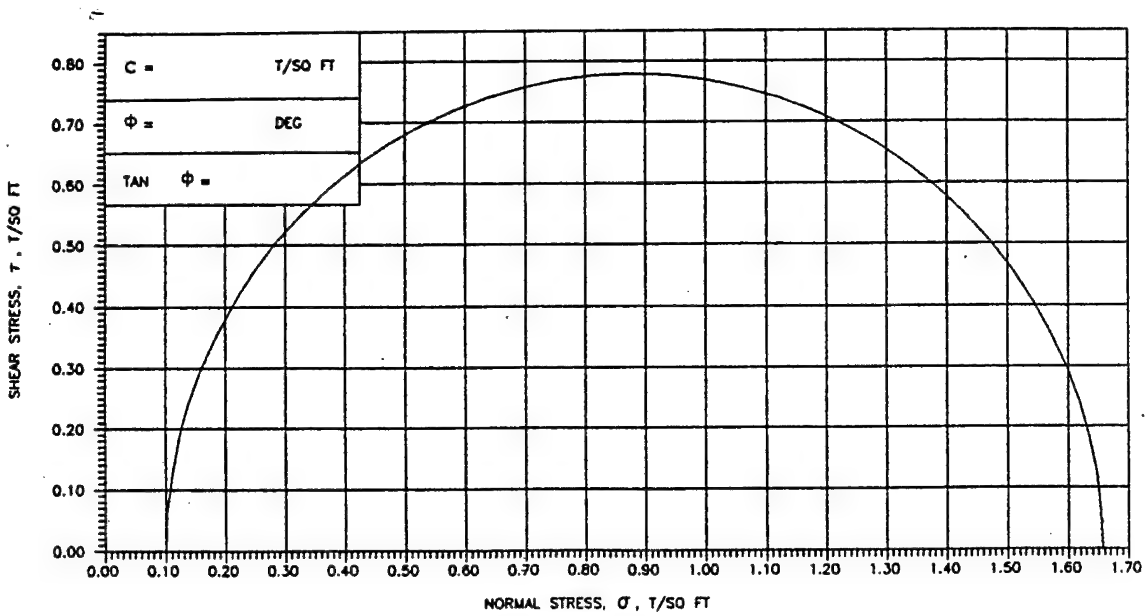
DEPTH/ELEV 481.91

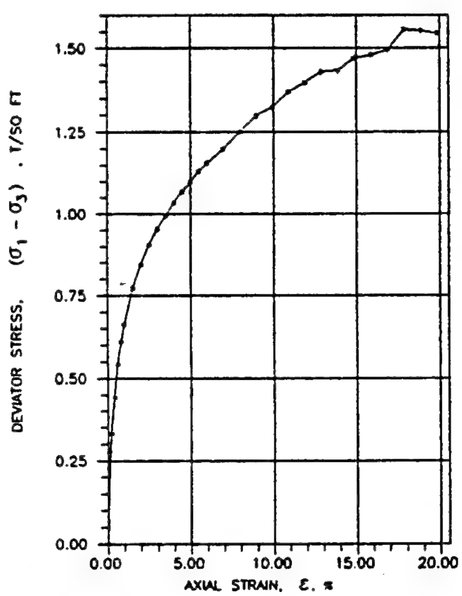
LABORATORY SPD | DATE 2-8-1991

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE
REV JUNE 1970


SHEAR STRESS (TSF)
6
4
2
0
2
4
6
8
1
2
3
EFFECTIVE STRESS
$\bar{\sigma}_3$ (TSF)
1.0
0.5
0
-0.5
-1.0
0
5
10
15
PORE PRESSURE
AXIAL STRAIN (ε) %
σ_3
$\bar{\sigma}_3$
○ 0.5 TSF 0.82
△ 1.0 " 1.78
□ 2.0 " 2.73
SPECIMEN TYPE: UNDIST.
TEST TYPE: $\bar{R}$
PROJECT: FANCHER CREEK DAM
BORING NO.: STA. 30+00
SAMPLES: (1) #114824
(2) #114825
(3) #114826
LAB: SPD
DATE: 2-8-1991





SPECIMEN NO. 114827			
INITIAL	WATER CONTENT, %	w_o	10.1
	DRY DENSITY LB/CU FT	γ_{d_o}	121.9
	SATURATION, %	S_o	71.6
	VOID RATIO	e_o	.382
BEFORE SHEAR	WATER CONTENT, %	w_c	14.2
	DRY DENSITY LB/CU FT	γ_{d_c}	121.8
	SATURATION, %	S_c	100
	VOID RATIO	e_c	.384
	FINAL BACK PRESSURE, T/SQ FT	u_o	7.2
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.10
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	1.56
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	400
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	---
INITIAL DIAMETER, IN.		D_o	2.90
INITIAL HEIGHT, IN.		H_o	6.27

CONTROLLED STRAIN TEST

DESCRIPTION OF SPECIMEN

LL	PL	PI	G_s Est. 2.70	TYPE OF SPECIMEN	TYPE OF TEST $\overline{R}$

REMARKS

PROJECT Fancher Creek Dam

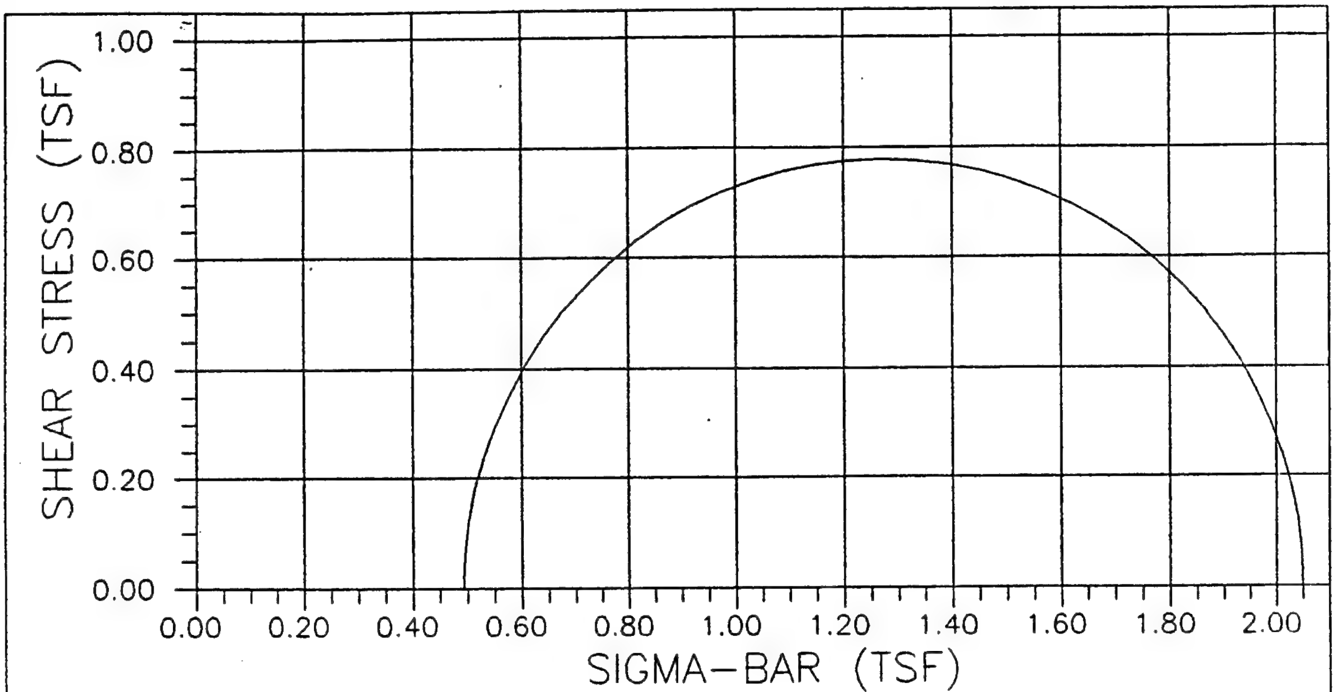
BORING NO. 59 + 30 SAMPLE NO. 1

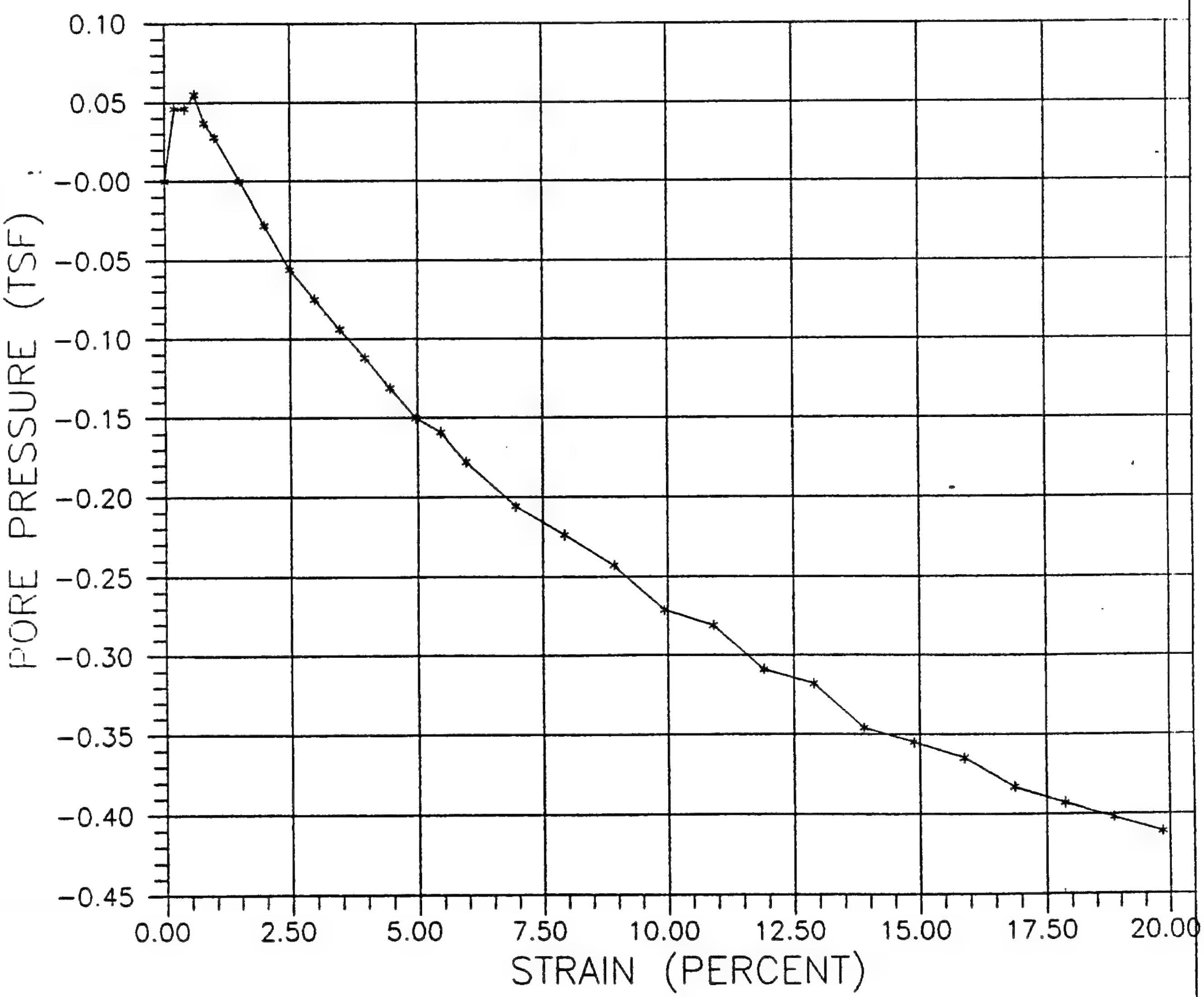
Elev. 467.78

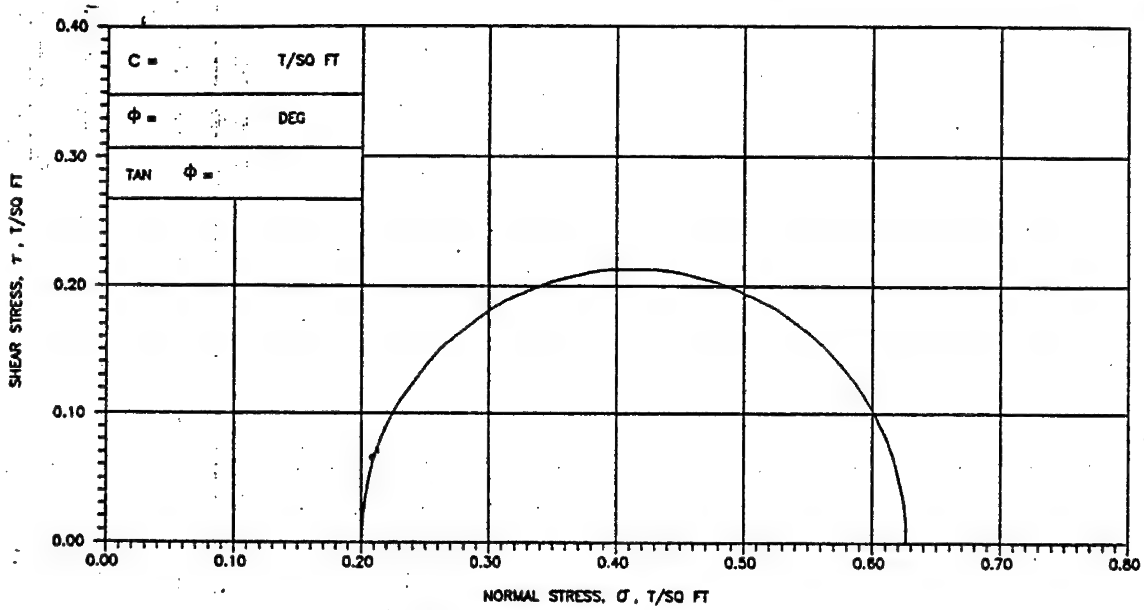
LABORATORY DATE 2/21/91

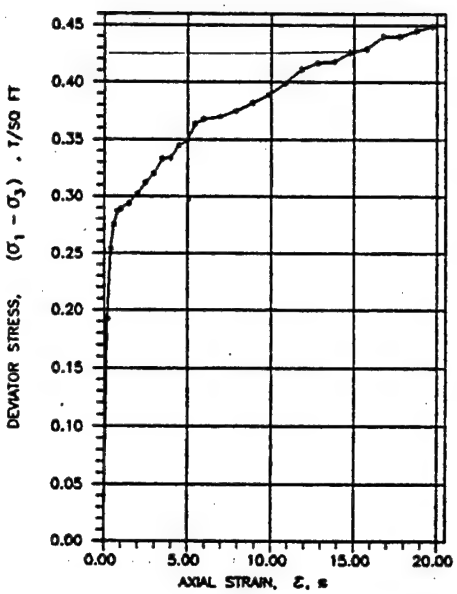
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089
REV. JUNE 1970


SHEAR STRESS (TSF)
1.00
0.80
0.60
0.40
0.20
0.00
0.00 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00
SIGMA-BAR (TSF)


PORE PRESSURE (TSF)
0.10
0.05
-0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
0.00 2.50 5.00 7.50 10.00 12.50 15.00 17.50 20.00
STRAIN (PERCENT)





SPECIMEN NO. 114828			
INITIAL	WATER CONTENT, %	w_o	13.2
INITIAL	DRY DENSITY LB/CU FT	γ_{d_o}	104.9
INITIAL	SATURATION, %	S_o	58.8
INITIAL	VOID RATIO	e_o	.606
BEFORE SHEAR	WATER CONTENT, %	w_c	19.3
BEFORE SHEAR	DRY DENSITY LB/CU FT	γ_{d_c}	110.7
BEFORE SHEAR	SATURATION, %	S_c	100
BEFORE SHEAR	VOID RATIO	e_c	.521
BEFORE SHEAR	FINAL BACK PRESSURE, T/SQ FT	u_o	7.2
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.20
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.45 .425
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	468
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	---
INITIAL DIAMETER, IN.		D_o	2.94
INITIAL HEIGHT, IN.		H_o	6.25

CONTROLLED STRAIN TEST

DESCRIPTION OF SPECIMEN

LL	PL	PI	G_s Est. 2.70	TYPE OF SPECIMEN	TYPE OF TEST $\overline{R}$

REMARKS

PROJECT Fancher Creek Dam

BORING NO. 59 + 30 SAMPLE NO. 2

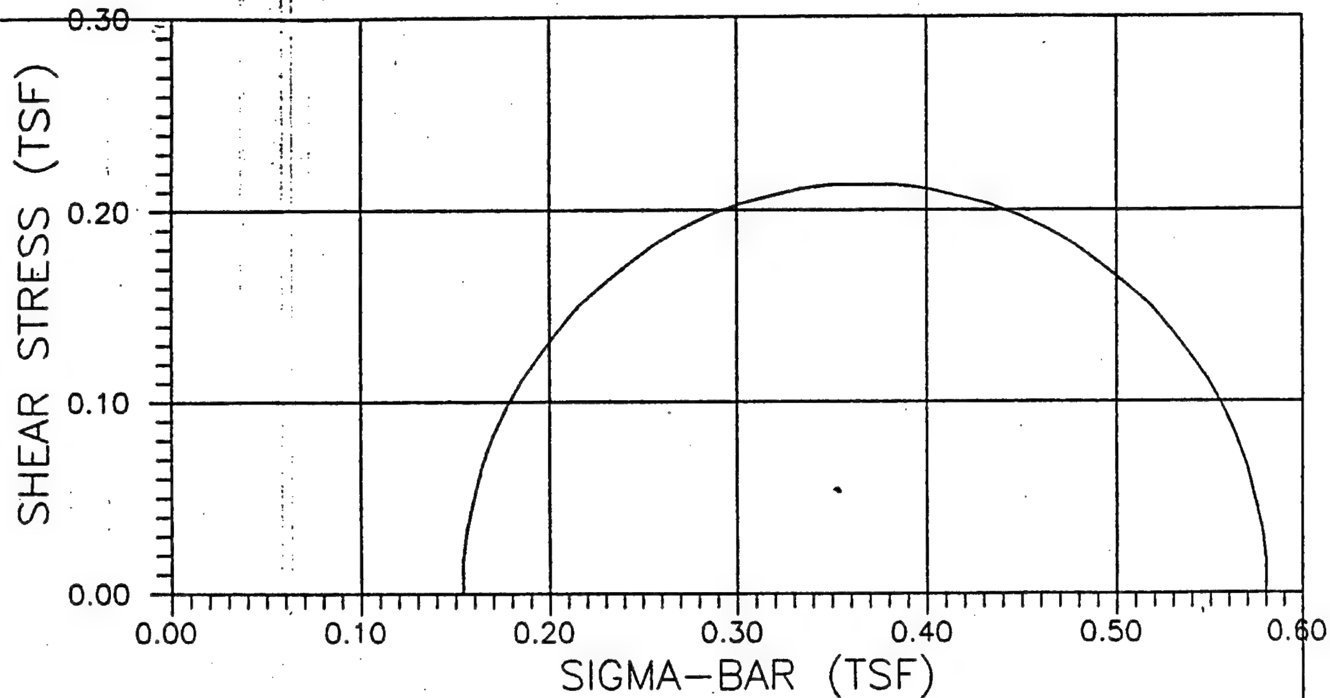
Elev. 467.78'

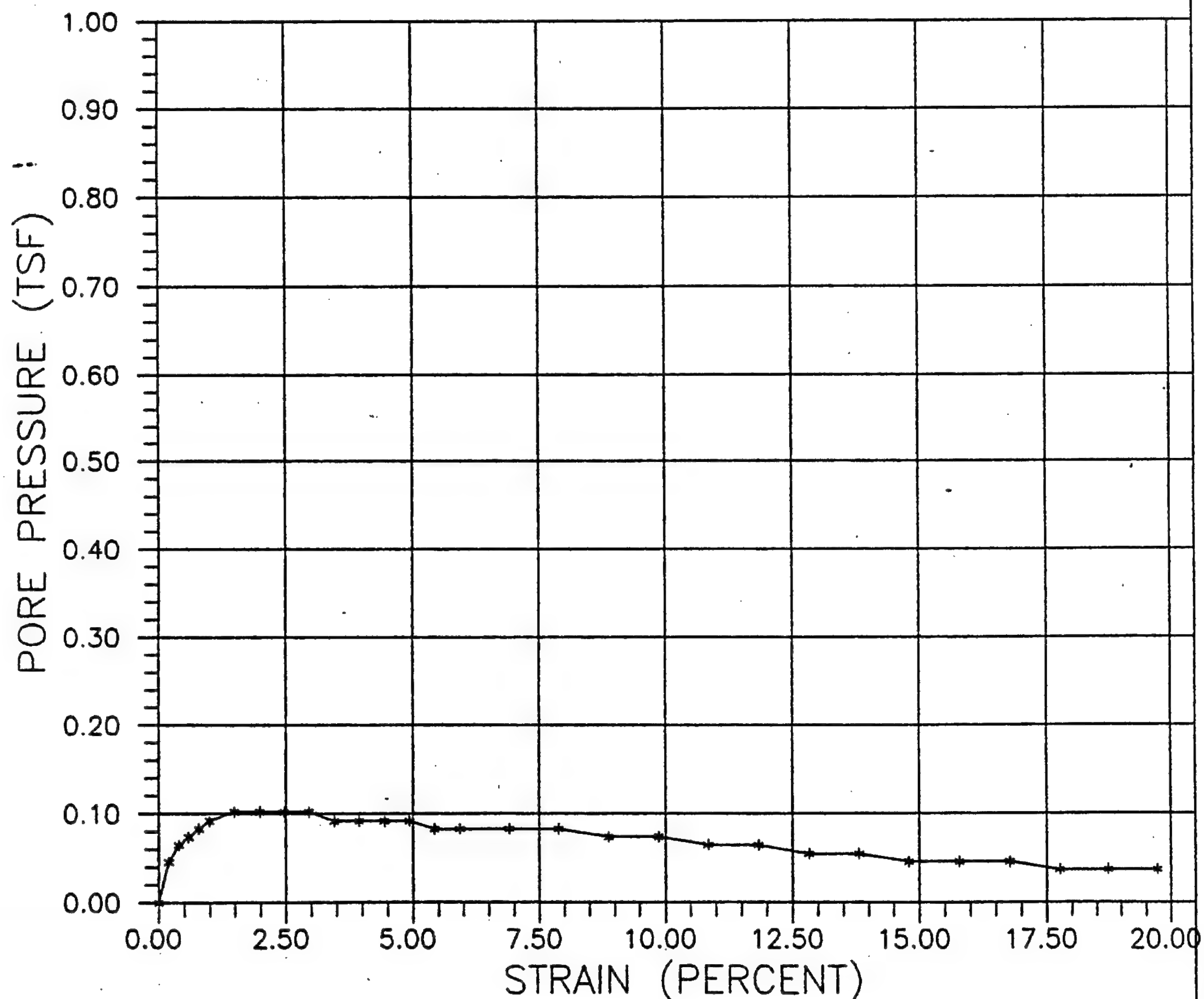
LABORATORY DATE 2/27/91

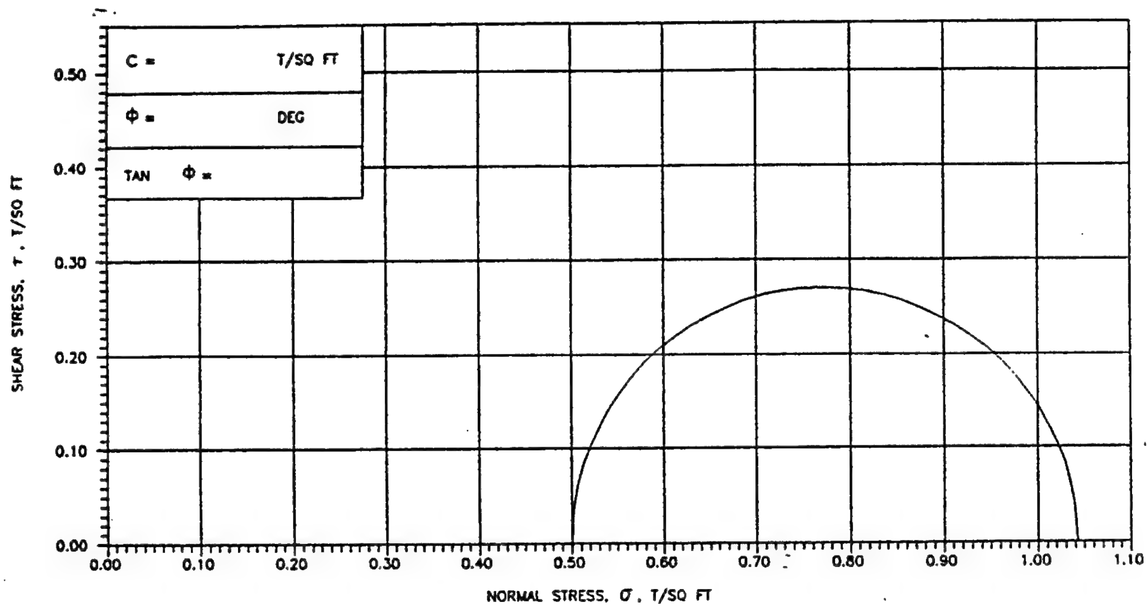
TRIAXIAL COMPRESSION TEST REPORT

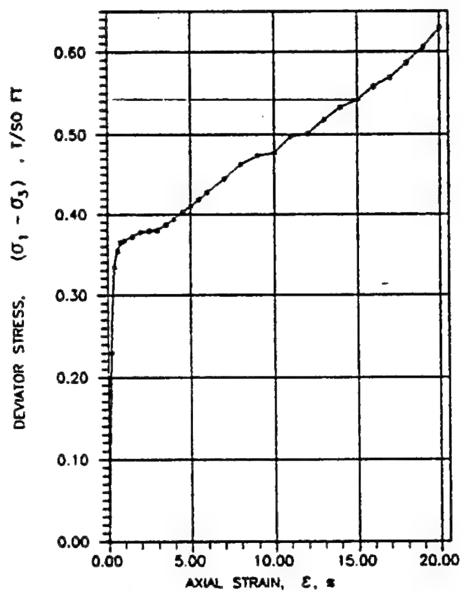
ENG FORM NO. 2089
REV. JUNE 1970

Div. No. 114828









SPECIMEN NO. 114829				
INITIAL	WATER CONTENT, %	w_o	12.2	
INITIAL	DRY DENSITY LB/CU FT	γ_{d_o}	112.3	
INITIAL	SATURATION, %	S_o	66.1	
INITIAL	VOID RATIO	e_o	.500	
BEFORE SHEAR	WATER CONTENT, %	w_c	18.0	
BEFORE SHEAR	DRY DENSITY LB/CU FT	γ_{d_c}	113.4	
BEFORE SHEAR	SATURATION, %	S_c	100	
BEFORE SHEAR	VOID RATIO	e_c	.486	
BEFORE SHEAR	FINAL BACK PRESSURE, T/SQ FT	u_o	7.2	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	.63	.54
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	544	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	--	
INITIAL DIAMETER, IN.		D_o	2.90	
INITIAL HEIGHT, IN.		H_o	6.57	

CONTROLLED STRAIN TEST

DESCRIPTION OF SPECIMEN

LL	PL	PI	G_s Est. 2.70

TYPE OF SPECIMEN

TYPE OF TEST $\bar{R}$

REMARKS

PROJECT Fancher Creek Dam

BORING NO. 59 + 30 SAMPLE NO. 3

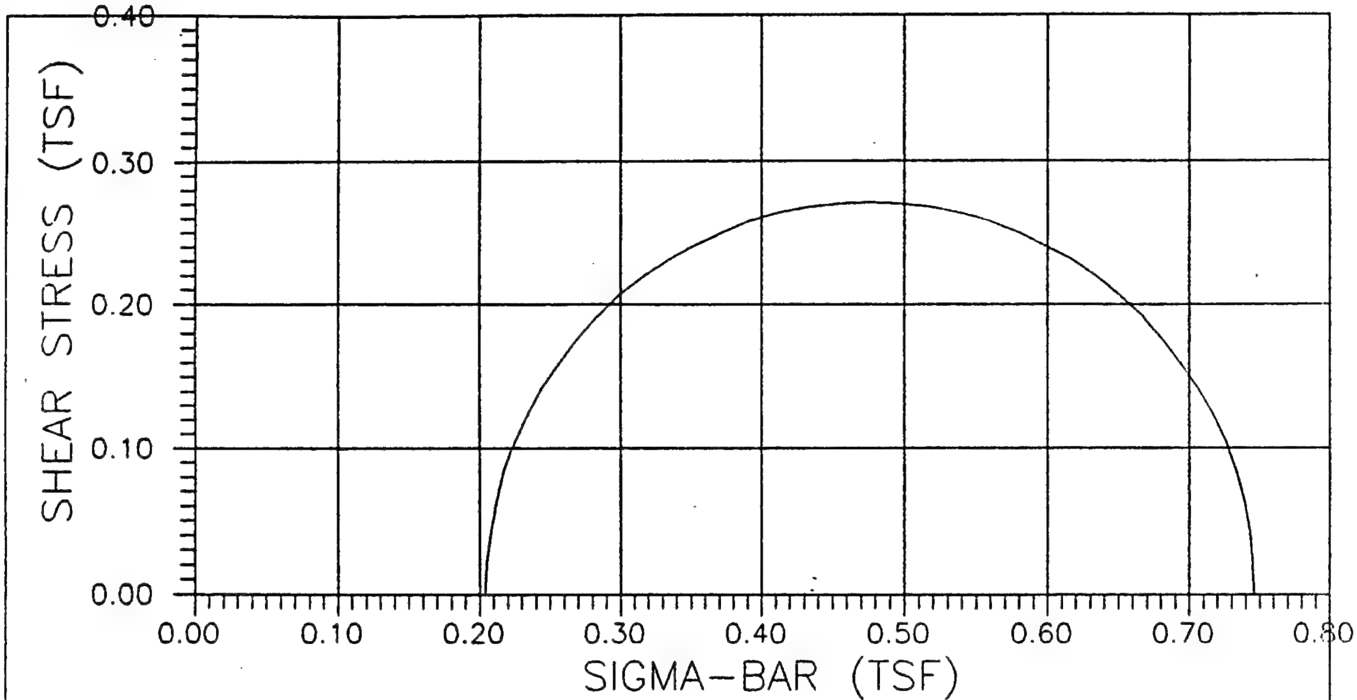
Elev. 467.78'

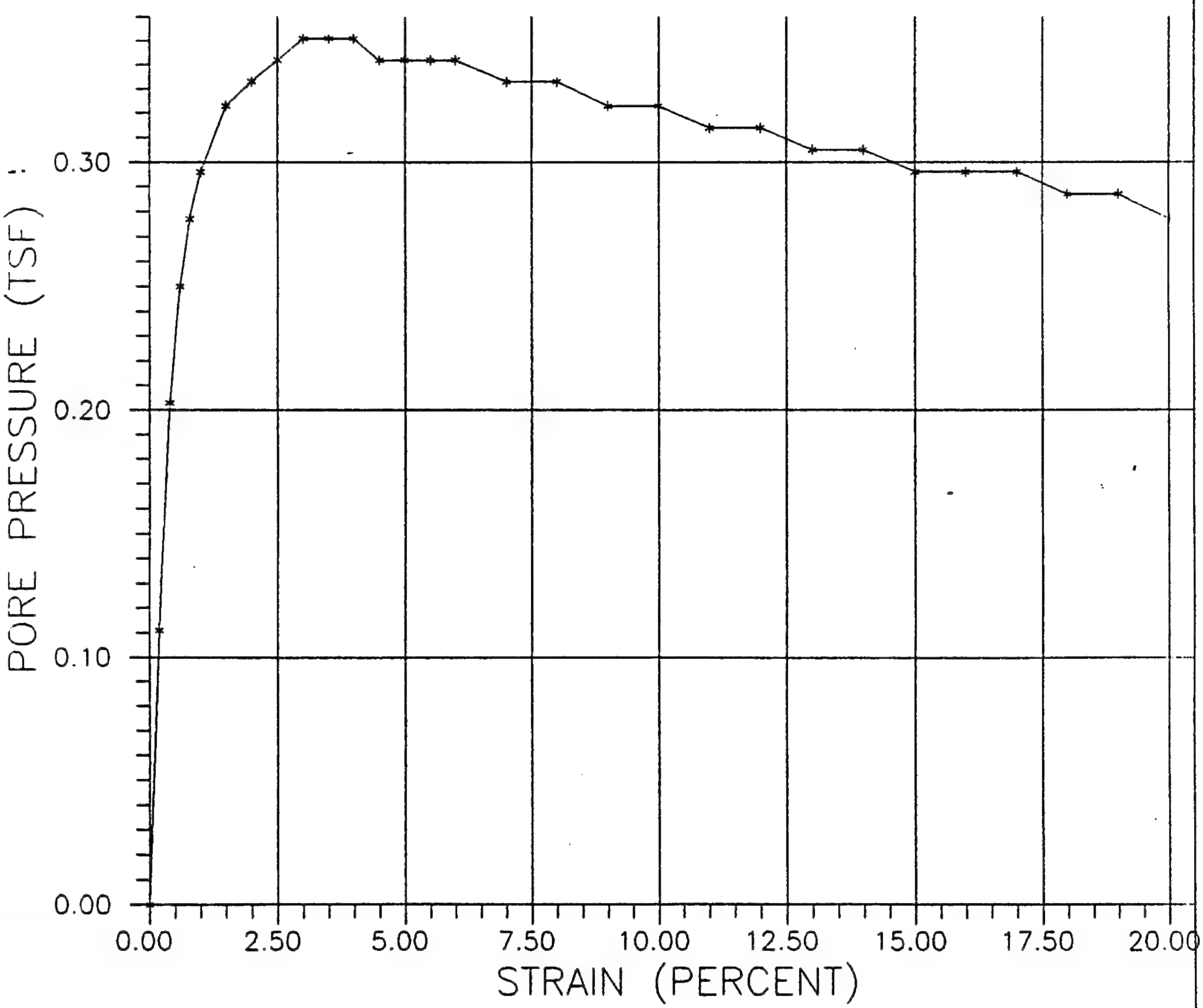
LABORATORY DATE 3/8/91

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089
REV. JUNE 1970

Div. No. 114829





U.S. ARMY CORPS OF ENGINEERS
SOUTH PACIFIC DIVISION LABORATORY, SAUSALITO, CA

FANCHER CREEK DAM

PERMEABILITY TEST REPORT

March 1991

				PRE-TEST CONDITIONS						POST-TEST CONDITIONS					
D B .	BORING NO.	SAMPLE NO.	DESCRIPTION	HT. (IN)	DIA. (IN)	VOID RATIO e	DRY DENS-ITY (PFC)	WATER CONT-ENT (%)	SATUR-ATION (%)	VOID RATIO e	DRY DENS-ITY (PFC)	WATER CONT-ENT (%)	SATUR-ATION (%)	COEFFICIENT OF PERMEABILITY, k, at 20 deg C (cm/sec)	
14824V	30 +00	1	Clayey sand (SC)	2.58	2.845	.4655	118.0	14.7	87.5			16.7	100	4.8 X 10-7	(Vertical)
14824H	30 + 00	1	" "	2.88	2.840	.4229	121.5	13.1	85.8			14.7	100	3.3 X 10-6	(Horizontal)
14825V	30 + 00	2	" "	2.14	2.864	.4386	120.2	12.4	78.3			14.5	100	2.9 X 10-7	(Vertical)
14825H	30 + 00	2	" "	2.17	2.887	.4477	119.4	11.4	70.5			14.5	100	1.8 X 10-6	(Horizontal)
14826V	30 + 00	3	" "	2.71	2.825	.3911	124.3	11.2	79.3			12.7	100	2.8 X 10-8	(Vertical)
14826H	30 + 00	3	" "	2.53	2.840	.4826	116.6	13.1	75.2			14.8	100	4.3 X 10-8	(Horizontal)
114828	59 + 30	2	Clayey sand w/ gravel (SC)	2.13	2.834	.4570	118.6	10.6	64.2			14.9	100	9.3 X 10-7	(Vertical)
114829	59 + 30	3	Clayey sand (SC)	2.35	2.872	.4275	121.1	12.6	81.6			15.6	100	3.2 X 10-6	(Vertical)

Note: All samples were undisturbed. G_s = 2.77 based on 114824 testing.

DEPARTMENT OF THE ARMY
SOUTH PACIFIC DIVISION, CORPS OF ENGINEERS
LABORATORY
25 LIBERTY SHIP WAY, SAUSALITO, CALIFORNIA 94965-1768

REPLY TO
ATTENTION OF:

CESPD-ED-GL (1110-1-8100b)

14 JUN 1991

MEMORANDUM FOR Commander, Sacramento District, ATTN: CESPK-ED-GS, Mr. Casey Jones

SUBJECT: Fancher Creek Dam

1. The results of laboratory testing on the subject project (7 Plates) are enclosed. Test results were telefaxed as testing was completed. Testing consisted of Sieve Analyses, Atterberg Limits, Water Content, Visual Classification and Triaxial Compression Tests.

2. Test Procedures. Testing generally conformed to the procedures described in Engineer Manual (EM) 1110-2-1906, Laboratory Soils Testing, 30 November 1970 with Change 2 dated 20 August 1986.

3. Soil Classification. Soils, for which laboratory determinations of particle-size characteristics, liquid limit, and plasticity index were conducted, have been classified according to ASTM Standard D 2487, "Classification of Soils for Engineering Purposes". Visual classification of soils have been classified according to ASTM Standard D 2488, "Description of soils (Visual-Manual Procedure)".

4. Significant Findings. None.

5. Total cost of testing is $10,785. Billing will be made by the Sacramento District Finance and Accounting Branch.

6. Reference DA Form 2544, No. ED-GS-91-33, dated 20 Feb 91.

FOR THE COMMANDER:

Encl

Dennis Thuet
DENNIS THUET
Director, SPD Laboratory

INTRA ARMY ORDER FOR REIMBURSABLE SERVICES For use of this form, see AR 37-108 and AR 37-110; the proponent agency is USAFAC.	1. RECEIVING OFFICE CONTROL NUMBER ☐ FUNDED ☐ AUTOMATIC	2. ORDER a. NUMBER: ED-GS-91-33 b. DATE: 20 Feb 91 3. CHANGE ORDER a. NUMBER b. DATE

4. TO BE PERFORMED BY *(Command, Installation or Activity)*, ADDRESS *(Include ZIP Code)*, AND AUTOVON NUMBER

US ARMY ENGINEER DIVISION LABORATORY
SOUTH PACIFIC DIVISION
P.O. BOX 37
SAUSALITO, CA 94966

5. ORDERED BY *(Command, Installation or Activity)*, ADDRESS *(Include ZIP Code)*, AND AUTOVON NUMBER

US ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
650 CAPITOL MALL
SACRAMENTO, CA 95814-4794

6. DESCRIPTION OF SERVICES TO BE PERFORMED

FANCHER CREEK DAM

1. This work order provides funding for testing of six undisturbed record samples collected from Fancher Creek Dam. Three 10-inch diameter by 15-inch long cylinders were taken from the random zone of the embankment at station 110+05, el 487.14 (site 1). Another three samples of the same dimensions were taken in the random zone of the embankment at station 148+12, el 480.82 (site 2). These samples will be delivered to the SPD laboratory by personnel from Bryte Yard on or about 22 Feb 91.

2. Perform the following tests:

Samples from Site No. 1

1. Consolidated-Undrained shear test w/pore pressure readings ($\bar{R}$), 6-inch diameter with σ_3 = 0.5 tsf.
2. Same as above with σ_3 = 1.0 tsf.
3. Same as above with σ_3 = 1.5 tsf.
4. Permeability tests with σ_3 = 0.5, 1.0 and 2.0 tsf.
5. MA to No. 200 sieve, AL (4 pt. LL W/P.L.)

Samples from Site No. 2

1. Consolidated-Undrained shear test w/pore pressure readings ($\bar{R}$), 6-inch diameter with σ_3 = 1.0 tsf.
2. Same as above with σ_3 = 2.0 tsf.
3. Same as above with σ_3 = 2.5 tsf.
4. Permeability tests with σ_3 = 0.5, 1.0 and 2.0 tsf.
5. MA & AL on all tested samples.

3. Provide the results of the above tests/services and 2 copies of the results by 19 April 1991 to Casey Jones, CESPK-ED-GS, telephone (916) 551-1890.

cc: F&A, PMO, Civ Proj Sec B (Weeks), Soil Des Sec (Jones, Townsend)

7a. NAME AND TITLE OF ORDERING OFFICER	b. SIGNATURE	c. DATE
LEWIS A. WHITNEY Chief, Engineering Division		

ORIGINATING FINANCE AND ACCOUNTING OFFICE APPROVAL

8a. ACCOUNTING CLASSIFICATION	b. AMOUNT
96X ~~4902~~ 3123 CG S96042 (BE1853151B29001)(GS)	$10,785.00

c. CHANGE

INCREASE AMOUNT ______ DECREASE AMOUNT ______ REVISED AMOUNT ______

9. Services to be performed pursuant to this order are properly chargeable to the appropriations or other accounts indicated above until 1 May 91 *(Day - Month - Year)*, the expiration date of this order.

10a. TYPED NAME AND TITLE OF APPROVING OFFICER	b. SIGNATURE	c. DATE
BETTY A. PUGNER Finance and Accounting Officer	[signature]	2/14/91

ACCEPTING OFFICER

11. **THE ABOVE TERMS AND CONDITIONS ARE SATISFACTORY AND ARE ACCEPTED.**

a. TYPED NAME AND TITLE OF ACCEPTING OFFICER	b. SIGNATURE	c. DATE ACCEPTED

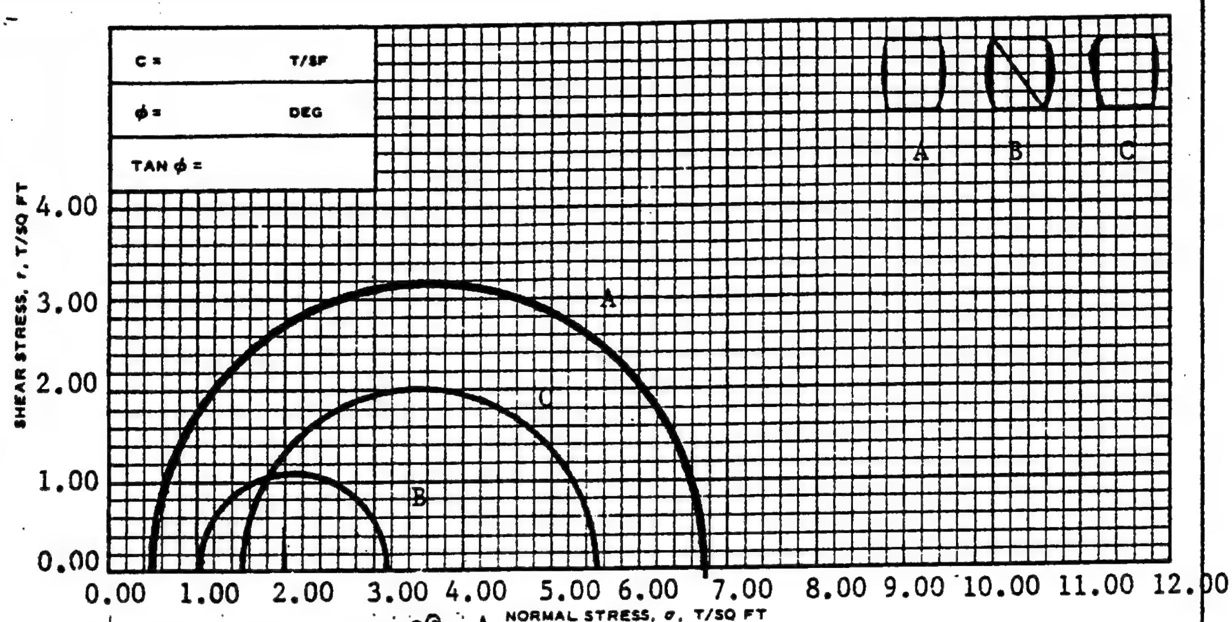
DA FORM 1 JUN 77 2544 EDITION OF 1 DEC 75 WILL BE USED UNTIL EXHAUSTED

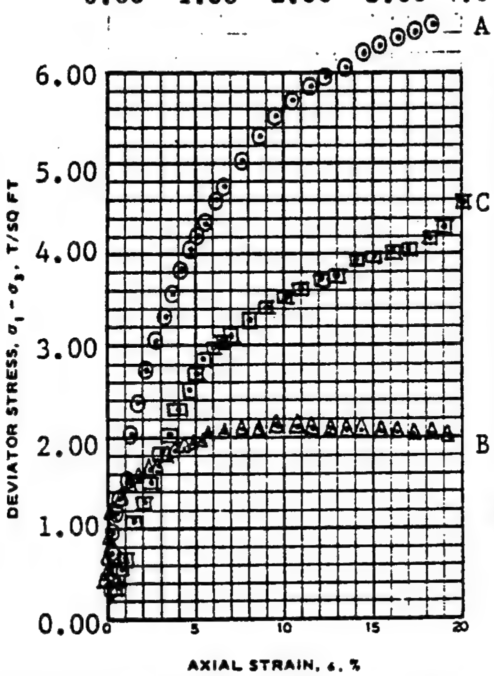
U.S. ARMY CORPS OF ENGINEERS, SOUTH PACIFIC DIVISION LABORATORY, SAUSALITO, CALIFORNIA

SOIL TEST RESULT SUMMARY

PROJECT: Fancher Creek Dam DATE: May, 1991

Division Number	Hole Number	Field Sample No.	Depth or Elevation	Laboratory Descriptive Classification	GRAVEL (PERCENT FINER) 12	6	3	1.5	3/4	3/8	SAND #4	#8	#16	#30	#50	#100	FINE #200	Liquid Limit	Plasticity Index	Specific Gravity +4	Specific Gravity -4	Field Moisture %
116514	110+05	1	487.14	Clayey sand with gravel (SC)			100	95	89	84	79	72	65	59	49	38	29	37	20	2.94	2.79	17.6
116515	110+05	2	487.14	Clayey sand (SC)			100	99	96	94	91	88	82	73	62	48	35	37	17	2.87	2.79	20.9
116516	110+05	3	487.14	Clayey sand (SC)			100	99	96	92	90	84	77	70	60	48	35	37	16	2.88	2.78	20.0
116517	148+12	1	480.82	Clayey sand with gravel (SC)		100	94	93	89	86	85	79	73	66	55	41	30	31	14	2.94	2.80	15.7
116518	148+12	2	480.82	Clayey sand with gravel (SC)		100	98	96	91	88	85	79	73	65	54	42	32	36	20	2.88	2.79	17.0
166519	148+12	3	480.82	Clayey sand with gravel (SC)			100	96	89	84	81	75	70	62	52	41	31	36	16	2.92	2.78	14.2





SPECIMEN NO.			A	B	C	
INITIAL	WATER CONTENT, %	w_o	12.6	21.9	14.0	
	DRY DENSITY LB/ CU FT	γd_o	120.6	101.7	103.0	
	SATURATION, %	S_o	89.8	92.5	61.2	
	VOID RATIO	e_o	0.371	0.626	0.605	
BEFORE SHEAR	WATER CONTENT, %	w_c	14.1	21.6	22.0	
	DRY DENSITY LB. CU FT	γd_c	121.1	102.7	104.5	
	SATURATION, %	S_c	100.0	100.0	100.0	
	VOID RATIO	e_c	0.372	0.573	0.584	
	FINAL BACK PRESSURE, T/SQ FT	u_o	6.48	5.76	5.40	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.50	1.01	1.51	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	6.24	2.12	3.96	
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	525	259	611	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$		2.05		
INITIAL DIAMETER, IN.		D_o	5.945	5.912	6.298	
INITIAL HEIGHT, IN.		H_o	13.85	11.68	13.42	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS

LL	PL	PI	Gs	TYPE OF SPECIMEN Undisturbed	TYPE OF TEST $\bar{R}$

REMARKS: Gs: 2.65 (Est.), for description of specimens, LL, PL, PI & Gs, please refer to preceding plates in this tests report.

PROJECT FANCHER CREEK DAM

S.P.D. No. 116514:A, 116515:B & 116516:C

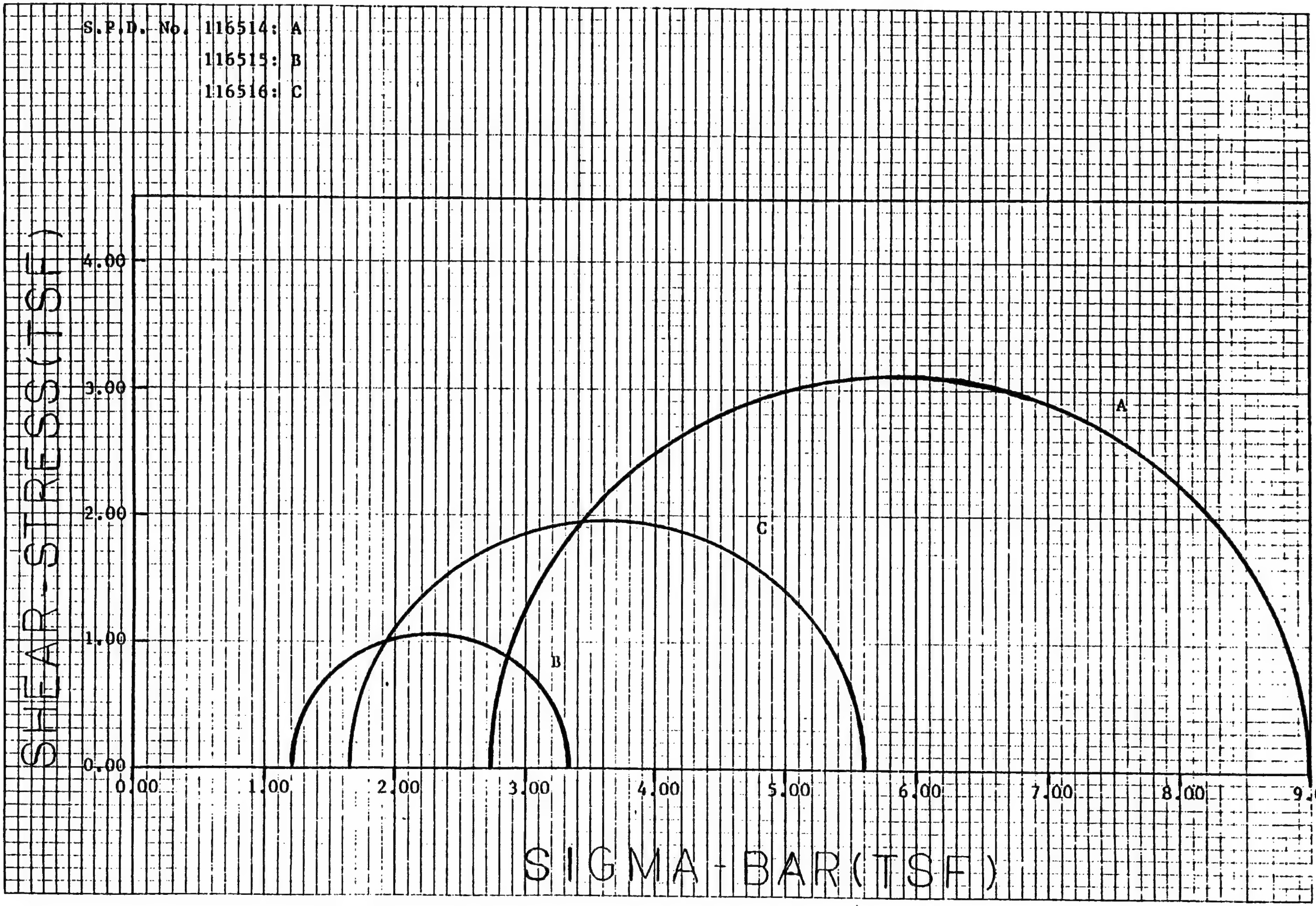
BORING NO. 110 + 05 SAMPLE NO. 1, 2 & 3

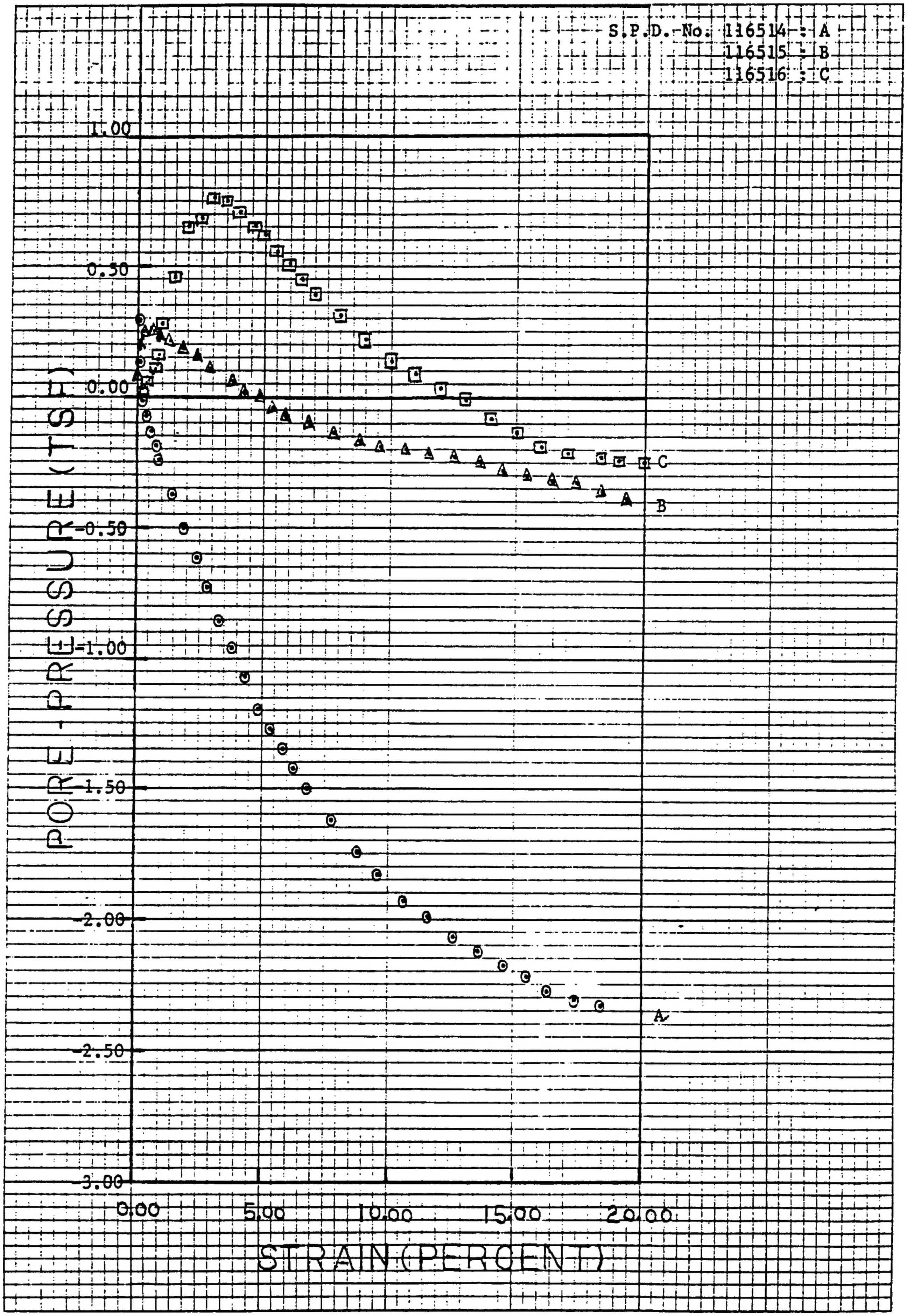
DEPTH/ELEV 487.14'

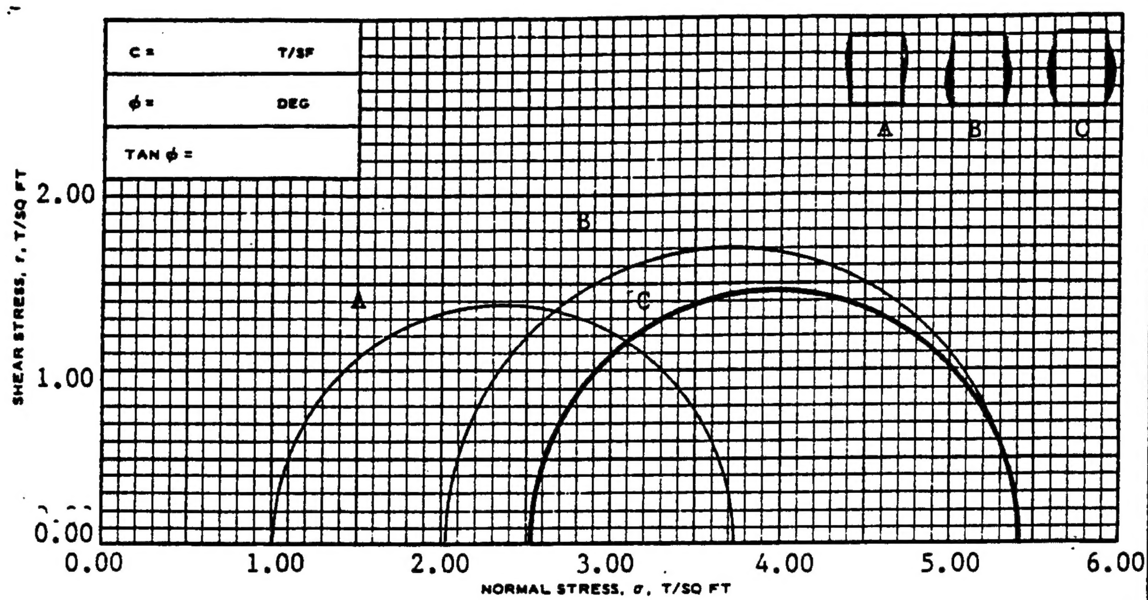
LABORATORY S.P.D. DATE

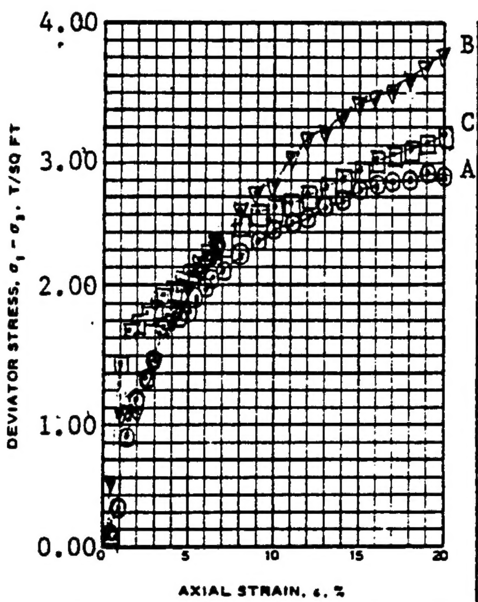
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE
REV JUNE 1970


S.P.D. No. 116514: A
116515: B
116516: C
SHEAR-STRESS(TSF)
4.00
3.00
2.00
1.00
0.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
SIGMA-BAR(TSF)
A
B
C


S.P.D. No. 116514 : A
116515 : B
116516 : C
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
-3.00
0.00
5.00
10.00
15.00
20.00
PORE-PRESSURE (TSF)
STRAIN (PERCENT)
A
B
C





SPECIMEN NO.			A	B	C
INITIAL	WATER CONTENT, %	w_o	13.5	16.5	15.4
	DRY DENSITY LB/CU FT	γd_o	106.7	113.1	115.9
	SATURATION, %	S_o	63.1	91.2	91.5
	VOID RATIO	e_o	0.579	0.490	0.454
BEFORE SHEAR	WATER CONTENT, %	w_c	18.6	17.3	15.4
	DRY DENSITY LB CU FT	γd_c	109.0	115.5	119.8
	SATURATION, %	S_c	100.0	100.0	100.0
	VOID RATIO	e_c	0.502	0.467	0.399
	FINAL BACK PRESSURE, T/SQ FT	u_o	6.12	5.04	4.68
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.01	2.02	2.52
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	2.71	3.39	2.89
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	475	420	408
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$			
INITIAL DIAMETER, IN.		D_o	6.746	6.133	6.251
INITIAL HEIGHT, IN.		H_o	13.74	12.70	13.63

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS

LL	PL	PI	Gs	TYPE OF SPECIMEN Undisturbed	TYPE OF TEST $\bar{R}$

REMARKS: Gs: 2.70 (Est.), for description of specimens, LL, PL, PI & Gs, please refer to preceding plates in this tests report.

PROJECT FANCHER CREEK DAM

S.P.D. No. 116517:A, 116518:B & 116519:C

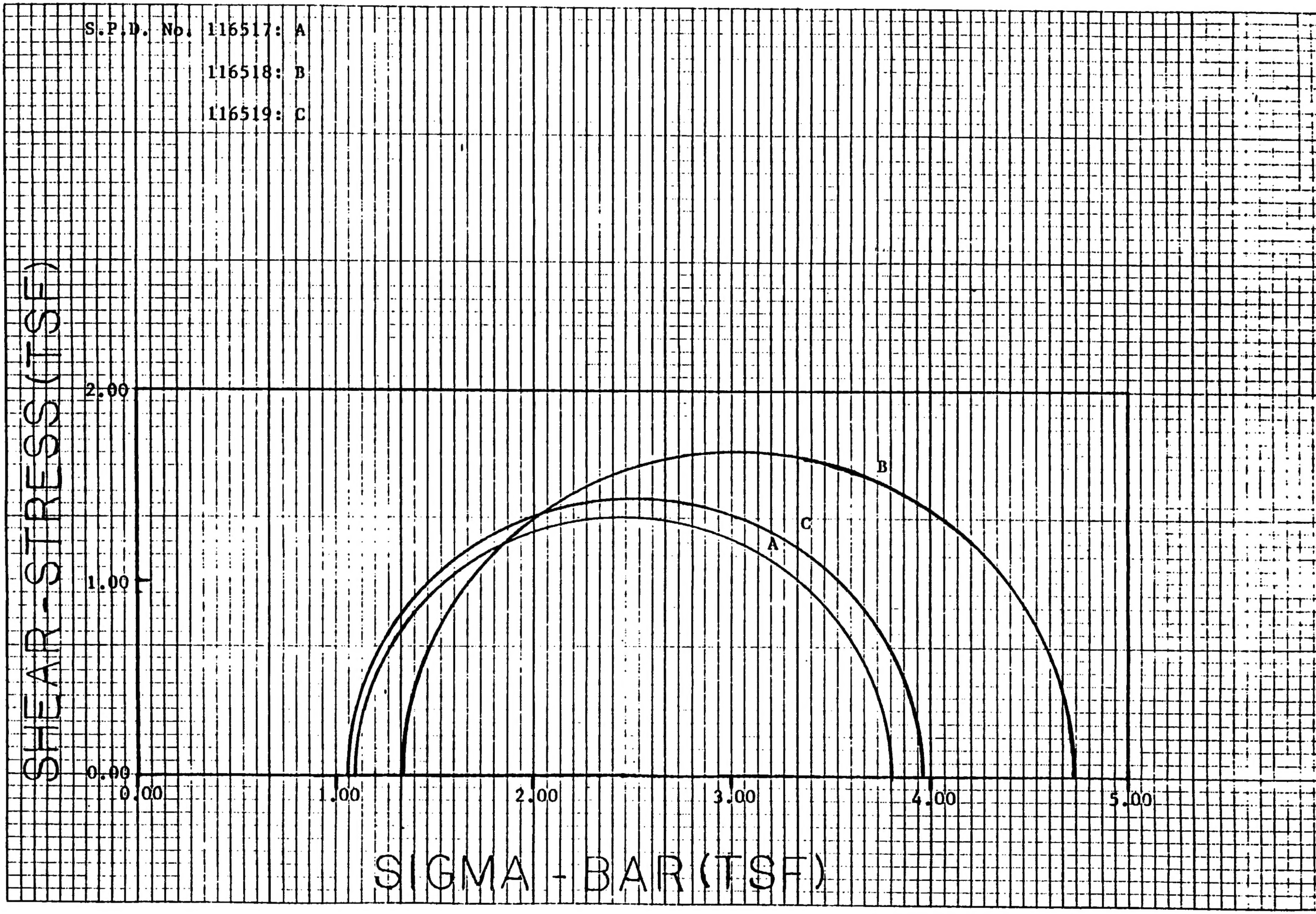
BORING NO. 148 + 12   SAMPLE NO. 1, 2 & 3

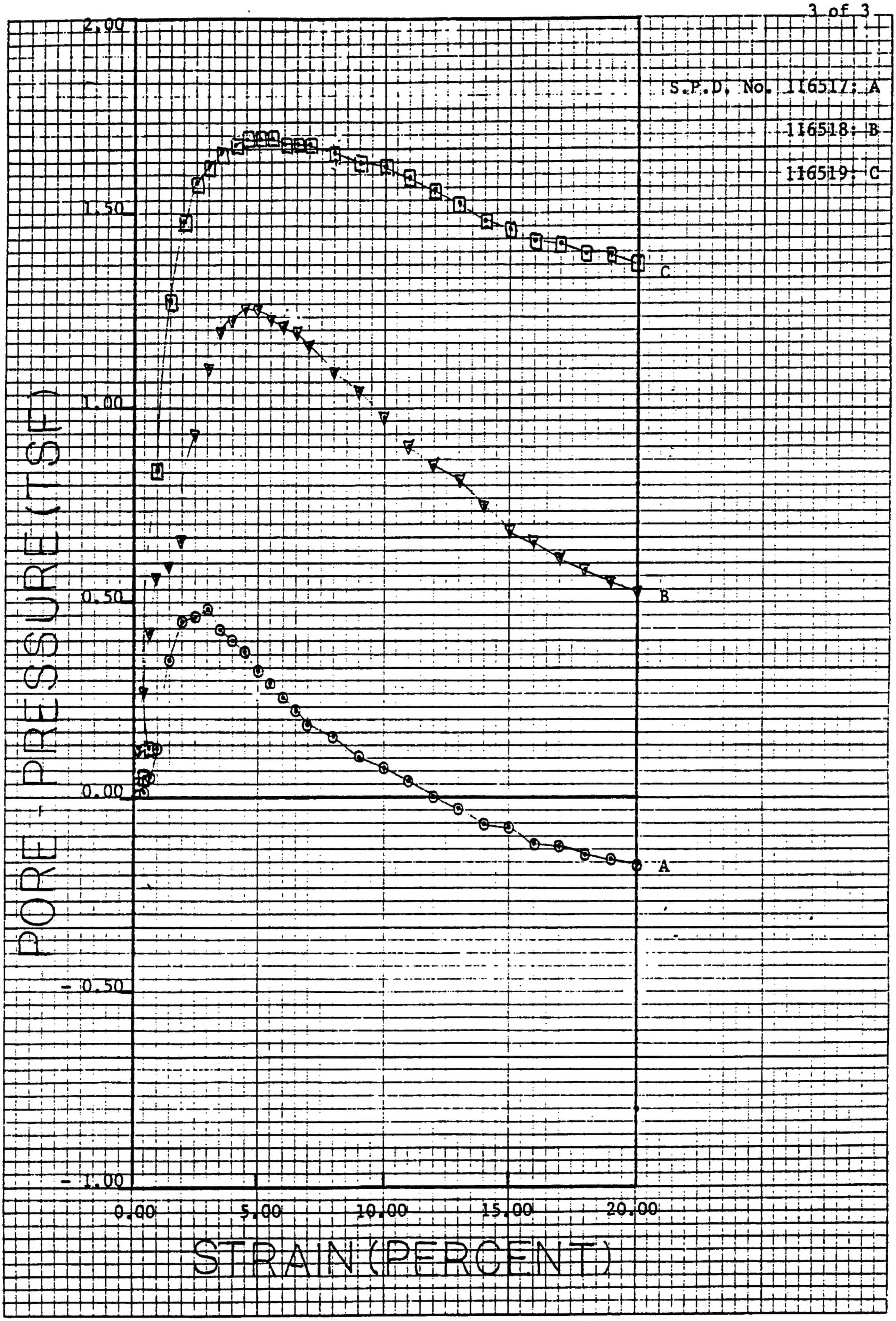
DEPTH/ELEV 480.82'

LABORATORY S.P.D.   DATE

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970   PREVIOUS EDITION IS OBSOLETE


S.P.D. No. 116517: A
116518: B
116519: C
SHEAR - STRESS (TSF)
2.00
1.00
0.00
0.00
1.00
2.00
3.00
4.00
5.00
SIGMA - BAR (TSF)
A
B
C


S.P.D. No. 116517: A
116518: B
116519: C
2.00
1.50
1.00
0.50
0.00
- 0.50
- 1.00
0.00
5.00
10.00
15.00
20.00
PORE PRESSURE (TSF)
STRAIN (PERCENT)
A
B
C